

THE ASCIDIANS OF SOUTH AUSTRALIA II. EASTERN SECTOR OF THE GREAT AUSTRALIAN BIGHT AND INVESTIGATOR STRAIT

by PATRICIA KOTT*

Summary

Seventy-two species of ascidians from South Australian waters are discussed. Fourteen of these are new and 42 have previously been reported from South Australian gulf waters. Morphological convergence to exploit the environment is evident in many of the forms present. The data support the existence of a marine faunal boundary at the eastern end of the Great Australian Bight. It is suggested that there are ecological factors responsible for the difference between the South Australian gulf and open coast ascidian fauna.

Introduction

Collections of ascidians have been previously made from St. Vincent and Spencer Gulfs (Kott 1972a) and from Port Phillip Bay and other locations on the Victorian coast (Millar 1966). The present collections are the first reported on from the southern coast of Australia between Middleton Beach, Albany (S.W. Aust.) and Spencer Gulf.

Seventy-two species of the Class Ascidiacea from South Australian locations (Fig. 60) are recorded. Of these, 42 had already been reported from St. Vincent Gulf, Spencer Gulf and Encounter Bay (Kott 1972a). Fourteen new species are described.

The association of species in the areas being considered differs from that in the gulf areas (Kott 1972a). Colonies in which each zooid maintains independent openings to the exterior are apparently favoured and many species demonstrate convergence in their adaptations to exploit the environment, especially in regard to their siphonal apparatus.

The large number of species taken, and especially the large proportion of new species, reflects the new habitats that are now being explored by SCUBA diving.

Type specimens are deposited in the South Australian Museum (SAM) or the National Museum of Victoria (NMV).

Order ENTEROGONA

Suborder APOUSOBRANCHIA

Family CLAVELINIDAE

Subfamily CLAVELININAE

Clavelina mirabilis n.sp.

Type Location: Waldegrave I.: in gravelly sand, attached to limestone, 23 m, *Shepherd*.

Holotype: SAM, E902. *Paratypes:* SAM, E903.

FIGS 1, 2

Description: The colonies consist of a spherical, sand covered, base from 2–5 cm in diam. with a thick, naked, branching stalk arising therefrom. The thoraces of zooids extend from the terminal branches, each enclosed in its own test covering. The living specimen is buff or yellow brown. In preservative, however, the test of the stalk is reddish-purple, although the terminal, free thoracic parts of the zooids are almost transparent. The gravel and sand attached to the spherical basal part forms a firm outer coat.

The zooids are up to 4 cm in length and extend parallel to one another down through the stalk portion into the base of the colony. The atrial aperture is sessile although the branchial aperture is on a short siphon. When the thorax is contracted, the atrial aperture is withdrawn to the middle of the dorsal surface, while the branchial aperture remains terminal. When the zooid is extended, however, the atrial aperture is produced to the anterior end of the zooid, more or less level with the branchial aperture. There are 15 longitudinal thoracic muscle bands extending from the ventral surface, from the branchial aperture and from the mid line between the branchial and atrial apertures. These extend towards the posterior end of the thorax, and continue in a wide band on either side of the abdomen. There are 18 rows of about 45 rectangular stigmata. The stomach is present in the posterior end of the abdomen and it has 4 thickenings in its wall.

Remarks: The zooids of this species are larger than other colonial species of the Clavelinidae, and the species is unusual in that the zooids

* Zoology Department, University of Queensland, Qld., Australia 4067.

extend the whole length of the colony and are not confined to the upper free part as in *Podoclavella cylindrica*; nor are they completely embedded as in *Clavelina baudinensis* (see below).

Most species of the family are attached to a substrate by the bottom of the stalk. In the present species, however, the unique adhesive property of the sides, as well as the bottom of the basal part of the colony, has resulted in an encrustation of sand, shell and other foreign particles to form its distinctive hard, spherical, surface which appears to have been embedded in the substrate to anchor the colony. The habit is most unusual since the spherical shape of the base of the colony does not appear to provide a rigid attachment or root system and there could be some movement of the colony in the substrate.

The habit may be compared with that of certain Stolidobranchia and Phlebobranchia where adherent sand forms a hard protective envelope around free-living individuals that are not fixed to the substrate.

***Clavelina nodula* n.sp.**

Type Location: Off Waldegrave I., Shepherd, *Holotype:* SAM, E898. *Paratypes:* SAM, E908.

FIG. 3

Description: The colony consists of a firm, translucent, branching stalk of 1.0 cm in diam. The zooids, separate from one another and each in its independent covering of delicate, completely transparent, test, are crowded around the free ends of the common stalk and its branches. The living zooids are bright orange in the centre but colourless in preservative. In the present specimens the zooids are mostly retracted into the common stalk. They are 4–8 cm long, depending on their degree of contraction. The abdomen is many times longer than the very short thorax. There are up to 20 oblique or longitudinal (sometimes coalescing) muscle bands on the thorax, of which 5–10 cross the mid-ventral line posterior to the branchial siphon. The thoracic musculature extends to the postero-dorsal corner of the thorax and continues in wide bands along either side of the abdomen. There are three rows of about 20 stigmata. The gut loop may be relatively long. The stomach is in the posterior end of the abdomen and its glandular lining is divided into four sections.

Remarks: The zooids of this species, although smaller, resemble closely those of *Pycnoclavella diminuta* (Kott), although there are fewer

stigmata in the present species. The colony form provides the main distinction between the species. In *P. diminuta* zooids are parallel to one another, and may be entirely independent although the test of adjacent zooids may fuse, or be confluent for varying distances from the base to form a stalk. In *Clavelina nodula* the zooids are not parallel to one another, but radiate from around the free end of a distinct common stalk. Clumps of protruding zooids at different points along the stalk precede the formation of a branch and appear to contribute to the later development of that branch. The addition of new zooids, developing from vascular stolons within the stalk, do not directly affect its diameter although they are accommodated in the stalk when withdrawn from the surface as in the present preserved specimens.

***Clavelina baudinensis* Kott, 1957: 87** (specimens with small larvae, from Rottnest I. and Laverion Bay). ?Millar, 1966: 363. Non *Clavelina baudinensis* Kott, 1972a: 4.

New Record: Elliston Bay. *Previous Records:* W. Aust. (Rottnest I.); Vic. (Laverion Bay)—Kott 1957.

Description: Small capitate colony consisting of an almost spherical head and short wide stalk. The test of the head is very delicate and completely transparent while that of the stalk is firmer. Zooids are embedded completely and open all around the surface of the head from which they radiate in toward the stalk. The preserved zooid is transparent with pigment spots in the mid line, dorsal and ventral to both apertures. There are about 12 longitudinal muscle bands in the thorax, of which only 2 extend across the mid line ventral to the branchial siphon. There are 16 rows of about 40 stigmata. The stomach is about half way down the abdomen and is small, with its inner glandular wall divided into four distinct sections.

Remarks: A re-examination of specimens previously identified as this species (Kott 1957) has shown that indeed there are two species represented, suggested by different larvae (Kott 1969a), and that *C. baudinensis* is distinguished by its slightly smaller zooids, with more rows of stigmata but with fewer longitudinal muscles on the thorax and crossing the ventral mid line. Zooids in the present species also tend to radiate in from the surface of the head in contrast to a more parallel arrangement observed in other specimens that rep-

represent a distinct new species to be described in a later work (Kott, in press (3)).

Podoclavella moluccensis Sluiter, Kott, 1972a: 5 and synonymy.

New Record: Elliston Bay. For *Previous Records, Description*, see Kott 1972a.

Remarks: The zooids rising from the basement membrane are separate from one another for their whole extent. There are four pigment spots dorsal and ventral to and on either side of the branchial aperture.

Podoclavella cylindrica (Quoy & Gaimard). Kott, 1927a: 5 and synonymy.

New Record: Waldegrave I. For *Previous Records, Description*, see Kott 1972a.

Podoclavella meridionalis Herdman, 1891: 603; 1899: 4. Hartmeyer, 1919: 104. Hastings, 1931: 81. Kott, 1957: 91.

New Record: Pearson I. *Previous Records:* W. Aust. (Cape Boileau, Cape Jaubert)—Hartmeyer 1919, Qld. (Great Barrier Reef, Mackay)—Hastings 1931; Kott 1957, N.S.W. (Port Jackson, Nelson's Bay, Port Stephens)—Herdman 1899.

FIG. 4

Description: Only a single specimen is available. This consists of a long stalk and rounded head slightly shorter than the length of the stalk. The whole zooid is about 10 cm high. The test is soft, transparent and gelatinous on the head but the test of the stalk is tougher. The test surrounding the siphons is especially delicate. The body wall of the zooid is pigmented blue to black and is easily seen through the transparent test. The branchial aperture is terminal and recurved so that the opening is directed laterally and downwards. The smaller atrial aperture from the antero-dorsal corner of the head is directed upwards. There are 3 rows of branchial tentacles at the base of the branchial siphon. The largest tentacles in the most posterior row alternate with moderate-sized tentacles in the middle row, while in the third and most anterior row there are twice the number of small tentacles. There is no true dorsal lamina although triangular languets are expanded from the transverse vessels at the side of the mid-dorsal line. There are 34 rows of at least 100 stigmata on each side of the body. The dorsal tubercle has an undulating longitudinal slit. In the present specimen the abdomen is very contracted and the course of the gut obscured. The stomach

is identified as a region where the gut wall has a glandular appearance but does not appear to be of greater diameter than the rest of the intestine. The body wall is thick and heavily pigmented. Longitudinal muscles extend from both siphons and cross one another on the thorax and extend down both sides of the abdomen.

Remarks: Although records of this species are few, it has a circum-Australian distribution. It could be a common component of the fauna in sheltered caves and reef overhangs where hitherto it has been inaccessible to collectors.

Oxycorynia arenosa n.sp.

Type Location: Investigator Strait (Sta. Y18), low, flat reef, 30 m. *J. Watson, Holotype:* NMV, H168. *Paratypes:* NMV, H169.

FIGS. 5-7

Description: The colonies form cylindrical or finger-like lobes only very slightly expanded at their free end. They are 1.0-1.75 cm in diam. and up to 9 cm long. They sometimes branch along their length or rise from a common base. The surface of the central lobe is sandy to a depth of about 2 mm, although the anterior portion of the zooids protrudes through the sandy layer and is covered by a thin layer of sand-free, transparent test. The central part of each lobe inside the sandy layer of test is soft and transparent. In preservative, the zooids have black pigment cells in the thorax which confer the dark colour seen through the sandy layer. Zooids open all around the surface of the cylindrical lobes for their whole length. Zooids extend toward the interior of the colony and their long posterior abdominal stolons continue down along the length of the lobe and into the base of the colony. The branchial and atrial openings are plain-rimmed and may be funnel-shaped. There are 12 broad longitudinal bands of muscle fibres on each side of the thorax extending along both sides of the abdomen. There are 6 rows of 20 long rectangular stigmata. The abdomen is about twice the length of the thorax with a long oesophagus and a spherical stomach in the posterior end of the abdomen. The zooid is only about 0.5 cm long.

Remarks: The small number of rows of stigmata and the arrangement of the zooids radiating in from all around the cylindrical stalk distinguishes this species from most others in the family where there are usually more rows of stigmata and the zooids open on the free ends of lobes and extend through the colony

parallel to one another. The parallel longitudinal thoracic muscles extend from both siphons along the length of the body and do not, as in the other species of this family, extend from across the endostyle. *Oxycorynia fascicularis* (Drasche) (see Michaelsen 1930 for synonymy), does have zooids radiating from around the head of the colony but here there is a distinct, zooid-free stalk distinguishing it from the present species and the zooids are completely embedded.

Subfamily HOLOZOINAE

Atapozoa marshi Brewin, 1956: 31.

New Record: Investigator Strait (Stns. Y14, 17). *Previous Record:* W. Aust. (Trigg I.) —Brewin 1956.

FIGS. 8, 9

Description: The colonies form lobes of varying length up to 6 cm and from 1 to 2 cm in diam. The zooid-free basal stalk is more or less the same diameter as the head of the colony, although it does not have adhering sand and is of a slightly firmer consistency. There is a very thin encrustation of sand on the surface open to the surface by separate, 6-lobed branchial and atrial apertures. There is a brown pigment spot above the dorsal tubercle. There are about 15 longitudinal muscles on the thorax and three rows of 15 stigmata. The oesophagus is short. The rounded stomach is especially small and is smooth-walled. There is a large group of male follicles to the left of the gut loop. In one colony there is a single immature embryo contained in a brood pouch from the postero-dorsal corner of the thorax.

Remarks: The colony is similar to that of *Oxycorynia fascicularis* (Drasche) (see Michaelsen 1930), and the shape of the colonies in both species varies in a similar fashion. The zooids, however, distinguish the species.

Atapozoa mirabilis n.sp.

Type Location: Elliston Bay, floor of cave, 6 m. *Other Records:* Elliston Bay, 11 m, *Shepherd*. *Holotype:* SAM, E899. *Paratype:* SAM, E896.

FIG. 10

Description: The colony consists of hollow lobes and lamellae coalescing with one another to form a thick and convoluted mass about 15 cm long and 4 cm high, traversed by passages and spaces. There are large common cloacal apertures present, randomly distributed around

the lobes, and these are often, but not always, near the top of the colony. The zooids are randomly arranged and do not appear to be in rows. They are seen as white dots in the semi-transparent and very soft test. The zooids open by their branchial apertures onto the outer surface of the colony, while the atrial apertures, directed posteriorly, open into the internal connecting cavities of the lobes and lamellae. Both apertures are 6-lobed and supported on siphons of which the branchial is half the length of the posteriorly directed atrial siphon. There is a short abdomen about the same length as the thorax and a bulbous vascular process extends from the posterior end of the abdomen. This process varies greatly in length in different zooids. Zooids are 2–3 cm long. The thorax has a layer of fine circular muscle bands continuous around the siphons, and there are fine longitudinal muscle bands internal to the circular muscles. These extend down the thorax and join into bands along either side of the dorsal surface of the abdomen and along either side of the vascular appendage. There are 3 rows of branchial tentacles, and 3 rows of 8 long rectangular stigmata. The dorsal lamina is represented by 2 pointed languets opposite the transverse vessels. There is no sign of the gonads in the gut loop in the present specimen. The stomach is spherical and smooth-walled and is present half-way down the abdomen. The oesophagus is fairly long. The rectum is often turned over into the proximal part of the posteriorly-directed atrial siphon, which is often blown out into what appears to be a large balloon-like reservoir.

Remarks: Both the colony and the zooids resemble *Atapozoa deerata* (Sluiter) and *A. vasia* (Millar) (see Kott 1967). The branchial aperture in the present species, however, is not so long, the zooids are not protected by furrows and ridges of the test as in *A. deerata*, and there is no central mass of test around which the cloacal spaces ramify, since here the centre of each lobe is occupied by a large common cloacal space. The vascular process has also been described previously for species of this genus (see *Sigillina deerata* Hastings 1931).

Atapozoa fantasiana (Kott). Kott, 1972a: 7 and synonymy.

New Record: Denial Bay. For *Previous Records, Description*, see Kott 1972a.

Remarks: In one specimen from Denial Bay, there is some purple pigment scattered through-



- Figs. 1, 2. *Clavelina mirabilis*. Fig. 1.—Colony. Fig. 2.—Thorax of zooid showing musculature.
 Fig. 3. *Clavelina nodula*. Colony.
 Fig. 4. *Podoclavella meridionalis*. Individual.
 Figs. 5–7. *Oxycorynia arenosa*. Fig. 5.—Portion of colony showing zooids. Fig. 6.—Outline whole colony. Fig. 7.—Zooid.
 Figs. 8, 9. *Atapozoa marshi*. Fig. 8.—Colony. Fig. 9.—Zooid showing posterior abdominal musculature.
 Fig. 10. *Atapozoa mirabilis*. Zooid.
 Figs. 11, 12. *Distaplia distomoides*. Fig. 11.—Colony. Fig. 12.—Zooid.
 Figs. 13, 14. *Pycnoclavella diminuta*. Fig. 13.—Colony. Fig. 14.—Zooid; musculature removed from abdomen.
 Fig. 15. *Polycitor obeliscum*. Zooid.

out the test and in the other specimen from the same station the test is semi-transparent and there are distinct rings of black pigment in the surface round each of the apertures. Otherwise both are similarly rather fleshy, flat and investing colonies, and the zooids are identical.

***Distaplia distomoides* (Herdman).**

Amaroucium distomoides Herdman, 1899: 75.

New Records: Waldegrave I. Elliston Bay.
Previous Record: N.S.W. (Port Jackson).

FIGS. 11, 12

Description: The colonies are cone-shaped and supported on a thick fleshy stalk. Living specimens are rusty-brown or brilliant purple, although in preservative they are cream to buff coloured. The test is soft and there is no adherent sand or foreign particles. The zooids are arranged in circular to oval systems all around the head. The stalk is zooid-free. There are longitudinal to oblique muscles on the thorax and there is the usual wide atrial opening protected by a well produced anterior lip. There are 8 longitudinal and oblique muscle bands on the thorax. There are 4 rows of about 12–15 stigmata crossed by parastigmatic vessels. The stomach is shield shaped and has 8 rounded ridges internally. The oesophagus is relatively short and there is a posterior stomach in the descending portion of the gut loop. There is a large rosette of male follicles to the right of the gut loop. As the colony becomes larger, the stalk is reduced, and the largest colonies are almost entirely sessile as in Herdman's type specimen.

Remarks: The present species resembles *Distaplia yallii* Herdman (see Van Name 1918) especially in the shape of the colony, and in the reduction in the length of the stalk as the zooid bearing head increases in size. It is distinguished by the small number of stigmata in each row and the 8 conspicuous glandular stomach folds. Herdman's type specimen of this species is redescribed in Kott (in press (2)).

***Distaplia stylifera* (Kowalevsky). Brewin, 1953: 60 and synonymy. Kott, 1957: 95. Millar, 1963: 713.**

Didemnum stylifera Kowalevsky, 1874: 443.

New Record: North of Waldegrave I. *Previous Records:* W. Aust. (Cape Jaubert to Fremantle). Qld. (Port Tennyson)—Kott

1957. Also the Red Sea, South Africa, and the east coast of north America (see Brewin 1953).

Description: The colony consists of a rounded head 1 cm long, on a stalk of less diameter but approximately equal length. There are 4 rows of 12 stigmata and the zooids are arranged in oval to circular systems opening evenly around the head. Mature gonads are not present.

Remarks: Although the shape of the colony and the zooids are identical with those of *D. stylifera*, the absence of the diagnostic gonads in a sac separated from the abdomen prevents the positive identification of this single specimen.

***Sycosoa pedunculata* (Quoy & Gaimard). Kott, 1972b: 234 and synonymy.**

Aplidie pedunculatum Quoy & Gaimard, 1834: 626.

New Record: Investigator Strait (Sta. Y16).
For Previous Records, Description, see Kott 1972b.

Remarks: A single small specimen only is available.

***Sycosoa cerebriformis* (Quoy & Gaimard). Kott 1972b:8 and synonymy.**

New Records: Denial Bay, near Ceduna, Elliston Bay. *For Previous Records, Description, see* Kott 1972a.

Family POLYCITORIDAE

***Pycnoclavella diminuta* (Kott), Millar, 1963: 715.**

Clavelina diminuta Kott, 1957: 89.

New Records: Elliston Bay, Spencer Gulf (Tipara Reef), St. Vincent Gulf (off Port Noarlunga, 15 m depth, on rock or epizoic on other ascidians). *Previous Records:* W. Aust. (Cape Boileau, Rottnest I.)—Kott 1957; Millar 1963.

FIGS. 13, 14

Description: Colonies are 2 cm high. Two or more zooids may be fused basally but anteriorly the thoraces of the zooids are always independent. The test is semi-transparent throughout and contains spherical, dark bodies, especially anteriorly. There are 3 rows of stigmata and about 12 fine longitudinal muscle bands on the very short thorax, extending along the ventral surface of the abdomen. The abdomen is about twice the length of the thorax.

The stomach, in the posterior end of the abdomen, is rounded and smooth-walled externally but there are some longitudinal interruptions in the glandular wall. Some of the thoracic muscle bands extend across the endostyle while the more dorsal bands extend from the atrial aperture and from across the mid-line between the apertures. The specimens are identical with the type specimens from Rottnest I. and are larger than those from Cape Boileau (Millar 1963).

Further colonies, apparently of this species, were collected from Tipara Reef in Spencer Gulf (Shepherd, 11 m., 20.viii.1971). The living zooids are yellow. As in Millar's specimens, the zooids are only 1 cm high, of which the upper one quarter is clear glassy test with the usual enclosed dark spherical bodies. The remainder of each zooid is encrusted with sand and is adherent to adjacent zooids. Basally, the test tapers into a fine root-like stolon with fine side branches and the basal part of the colony is a tangled mass of these stolons. There does not appear to be any organic continuity between the stolons of adjacent zooids and there is no basement membrane as in previously described specimens. The zooids have only 5 thoracic muscle bands which extend along both sides of the abdomen in fine bands; and although there are the usual 3 rows of stigmata, there are only 16 stigmata in each half row. Numbers of both muscle bands and stigmata are therefore much reduced in these specimens from Tipara Reef. The stomach is of the usual form. Embryos start their development at the base of the oviduct as is characteristic of this genus. Well developed embryos taken from the oviduct about half way up the abdomen are 1.3 mm long, the tail is wound once around the body, there is an ocellus but no otolith, and there are three 'tube'-like papillae characteristic of the genus (Trason 1963).

Remarks: All specimens share the pycnoclavelid characters of short thorax and large eggs which are fertilized at the base of the oviduct, developing as they pass up toward the atrial aperture. The absence of the basal membrane in the specimens from Tipara Reef could be a response to the sandy substrate in which they are rooted. There is considerable variation, however, in the number of stigmata and the number of longitudinal muscle bands in the specimens, which is not related to the size of the zooid. Further collecting may demonstrate that more than a single species is involved.

Polycitor giganteum (Herdman). Kott, 1972a: 9 and synonymy.

New Records: Waldegrave I., Elliston Bay, Pearsup I., Investigator Strait (Stns. X15, 21). **Previous Records:** See Kott 1972a.

Description: The present colonies vary from small, conical and sessile, to large and spherical, constricted from a sandy base. The basal test is translucent but the test of the head is almost glassy and transparent. Zooids open all round the head and radiate into the base of the colony as is usual for the species. There are 15 longitudinal thoracic muscle bands extending in a wide band along the ventral half of the abdomen. There are 10 rows of about 20 stigmata. The stomach, in the posterior end of the abdomen, has four folds. Gonads are present in the gut loop.

Polycitor obeliscum n.sp.

Type Locality: Investigator Strait (Stn. Y18), 30 m. on a low, flat reef, *Watson*. **Holotype:** NMV, H167.

FIG. 15

Description: The colony forms a pointed, sessile cone. The test is gelatinous and firm, and there is sand basally. Zooids open all around the surface and appear to be arranged more or less in longitudinal lines. Zooids radiate in from the surface to the base of the colony. The abdomen is about four times the length of the thorax. Both apertures are 6-lobed and the atrial aperture is on a short siphon. There are 20 longitudinal thoracic muscles and some transverse muscles on the thorax. There are 5 rows of about 12 stigmata. The stomach which is present in the posterior third of the abdomen is large and smooth-walled although it may be collapsed into folds. There is a small, rounded, posterior stomach.

Remarks: A colony of this species superficially resembles that of *Distaplia distomoides*. The zooids, however, are typically of the genus *Polycitor* and are distinguished from other species in that genus by the very small number of rows of stigmata.

Eudistoma renieri (Hartmeyer). Kott, 1972a: 10 and synonymy.

New Record: Elliston Bay. **Previous Records:** see Kott 1972a.

Description: The present colony forms an irregularly elongate or oval to circular cushion with rounded walls. It is up to 1.5 cm high

and 3 cm in diam. It is fixed by most of the basal surface and the upper surface is smooth. In the living colony, the circles of zooids show as bright red stars in a pale test. However, in preservative, the stars are colourless and the test is black, the pigment being contained in the round cells in the test. The zooids are arranged in circles of up to 6, with the atrial openings adjacent to one another in the centre of the circle forming a pseudo-cloacal opening. There are strong longitudinal muscles on the siphon but there is no conspicuous circular sphincter. There are 15 strong muscle bands on the thorax extending along either side of the abdomen. There are 15 stigmata in each of the three rows.

Remarks: The arrangement of the zooids in circles is usual for this and other related species of the genus. The fleshy firm consistency of the colony is typical of the species.

Cystodytes dellechiaiei (Della Valle). Kott, 1972a: 11 and synonymy.

New Record: Elliston Bay. For *Previous Records, Description*, see Kott 1972a.

Family POLYCLINIDAE

Subfamily EUHERDMANINAE

Euherdmania australis Kott, 1957: 103.

New Records: Elliston Bay, off Waldegrave I., Investigator Strait (Stn. Y19). *Previous Records:* Vic. (Port Phillip Heads). N.S.W. (Camden Haven)—Kott 1957.

FIGS 16-18

Description: The colonies are formed of the usual sandy, finger-like, lobes containing a single zooid. The atrial aperture is sessile in the middle of the obliquely flattened to concave free end of the lobe. The branchial aperture is just ventral to the flattened free end and is protected above by a crescentic flap of sand-stiffened test which covers the opening. The aperture itself is in a sand-free area covered by this flap. There are 13 rows of stigmata with parastigmatic vessels. Branchial papillae are present in the middle of the primary and parastigmatic transverse vessels on each side of the body. The anus is present half way up the thorax and has 10 pointed lobes on the border. The stomach is small, with about 16 rather irregular and often branching folds. In the specimens from Waldegrave I., about 8 developing embryos are present in the thoracic part of the oviduct, the most

mature embryo being present toward the distal end of the duct. The eggs are therefore fertilised at the base of the oviduct and appear to start their development as they move up toward the opening. Testes are bunched in the short posterior abdomen. Muscles are present, especially round the dorsal border of the branchial aperture, but do not extend far down the thorax. When the anterior part of the zooid is contracted, the lower part of the thorax is pulled upwards, placing the opening of the oviduct opposite the atrial opening.

Larvae: The larvae are 0.9 mm long. They have 3 shallow, wide, papillae in the mid-line. Sets of 3 median ampullae are present in the intervals between the papillae, and in each set the middle ampulla is larger and its free end is flattened, while the dorsal and ventral ampullae in each set are smaller and conical. Small vesicular cells are supported all over the body wall of the larvae.

Remarks: The larva is of the polyclinid type, developing ampullary vesicles and with the usual papillary cells surrounded by accessory cup-like suckers. The papillae are not modified as in other species of this and the related genus, *Placentula* (see Kott 1969a).

Ritterella herdmania Kott, 1957: 102; 1972a: 11 and synonymy.

New Record: Elliston Bay. *Previous Records:* see Kott 1972a.

Description: The colonies consist of small slender lobes, 1 cm long, with expanded spatulate tips, joined basally. Minute zooids open around the border of the lobes. There are 5 rows of stigmata and 5 stomach folds. Papillae are present on the transverse vessel.

Pseudodistoma australis Kott, 1957: 101; 1963: 78.

New Records: Waterloo Bay, Waldegrave I. *Previous Records:* W. Aust. (Rottnest I.)—Kott 1957, 1963.

FIG. 19

Description: Colonies are soft, rounded and sessile, up to 2 cm in diam. and no more than 0.5 cm thick. The test is especially soft and semi-transparent. The zooids may be orange-brown with flecks of black, and in the preserved colony spherical black pigment-cells remain. Zooids open over the upper surface by two separate, 6-lobed openings. There are 3 rows of about 20 stigmata. There are 15 strong longitudinal muscle bands on the thorax

which extend as a single band down the ventral side of the abdomen and onto the posterior abdomen. The stomach is small and smooth walled, with a distinct typhlosolar line, and is present half way down the abdomen. The oesophagus is fairly short. The thoracic muscles extend down the ventral side of the abdomen and to the left of the intestinal loop onto the posterior abdomen, which, in these specimens, appears to arise from the left side of the intestinal loop owing to the strong contraction of the body musculature. The thorax, abdomen and posterior abdomen are of equal length. Gonads are not developed in the present specimens. In specimens from Waldegrave I, there is occasionally a large balloon-like brood pouch.

Remarks: The specimens have been compared with the type specimen of *Pseudodistoma australis* and found to be identical, although in the type the posterior abdomen is better developed with mature gonads. *Pseudodistoma cynusense* Pérès, 1952, and *P. fragilis* Tokioka, 1958, are related species with a sessile colony, short abdomen and oesophagus, small smooth stomach, and the testis follicles bunched at the posterior end of the posterior abdomen. *P. cynusense* has only 12 stigmata per row, while both *P. australis* and *P. fragilis* have 20 or more stigmata per row. *P. fragilis* is distinguished from the present species by the presence of up to 3 embryos in a brood pouch, while in *P. australis* only a single embryo has been found in the brood pouch that is constricted from the postero-dorsal aspect of the thorax (see Kott 1963).

***Pseudodistoma cynusense* Pérès, 1952: 37.**

New Record: Elliston Bay. **Previous Records:** Mediterranean—Pérès 1952.

FIG. 20

Description: The colony is a very soft, irregularly rounded, inverted saucer shape, 8 cm in diam. and about 1 cm high in the centre. The surface is very smooth and there are no adherent or included foreign bodies. The test is slightly transparent, cloudy and of creamish colour. Zooids open separately to the exterior over the upper surface. The siphons are fairly muscular and there are 12 fine longitudinal muscle bands on the thorax extending along both sides of the abdomen and posterior abdomen. There are 3 rows of stigmata with about 12 stigmata per row. The abdomen is slightly longer than the thorax, although the posterior abdomen is about 3 times the length of the

abdomen. The stomach is half way down the abdomen and externally is smooth, although internally there appear to be 4 glandular ridges. There are minute mulberry-like cells in the common test, from 0.01–0.02 mm in diam.

Remarks: It has not been possible to separate the present colony from Pérès' Mediterranean species. The colony form and consistency, the number of stigmata, and the size and shape of both the stomach and of the zooid are identical. *Pseudodistoma aurea* (Brewin 1957) and *P. mauritiana* Vasseur, 1967, both form large fleshy colonies. However, in these forms, the abdomen is very much longer than the thorax and the oesophagus is especially long. *Pseudodistoma fragilis* (Tokioka, 1958) and *P. australis* also form fleshy investing colonies but they are much thinner than the present specimen and have 25 stigmata in each row, distinguishing them from the present specimen which has only 12. The present colony is considerably more extensive than specimens of *P. australis* so far available.

***Pseudodistoma cercum* Michaelsen, Kott, 1972a: 12 and synonymy.**

New Records: Elliston Bay, Waldegrave I., St. Francis I. **For Previous Records, Description, see Kott 1972a.**

FIGS. 21, 22

Remarks: The species is distinguished from other stalked forms by the relatively large number of thoracic muscles (30–40). The stomach is rather capacious and has its internal glandular wall divided into four sections (see Michaelsen 1924). This also helps to distinguish the species from *P. australis* in which the stomach is especially small, shallow and smooth walled.

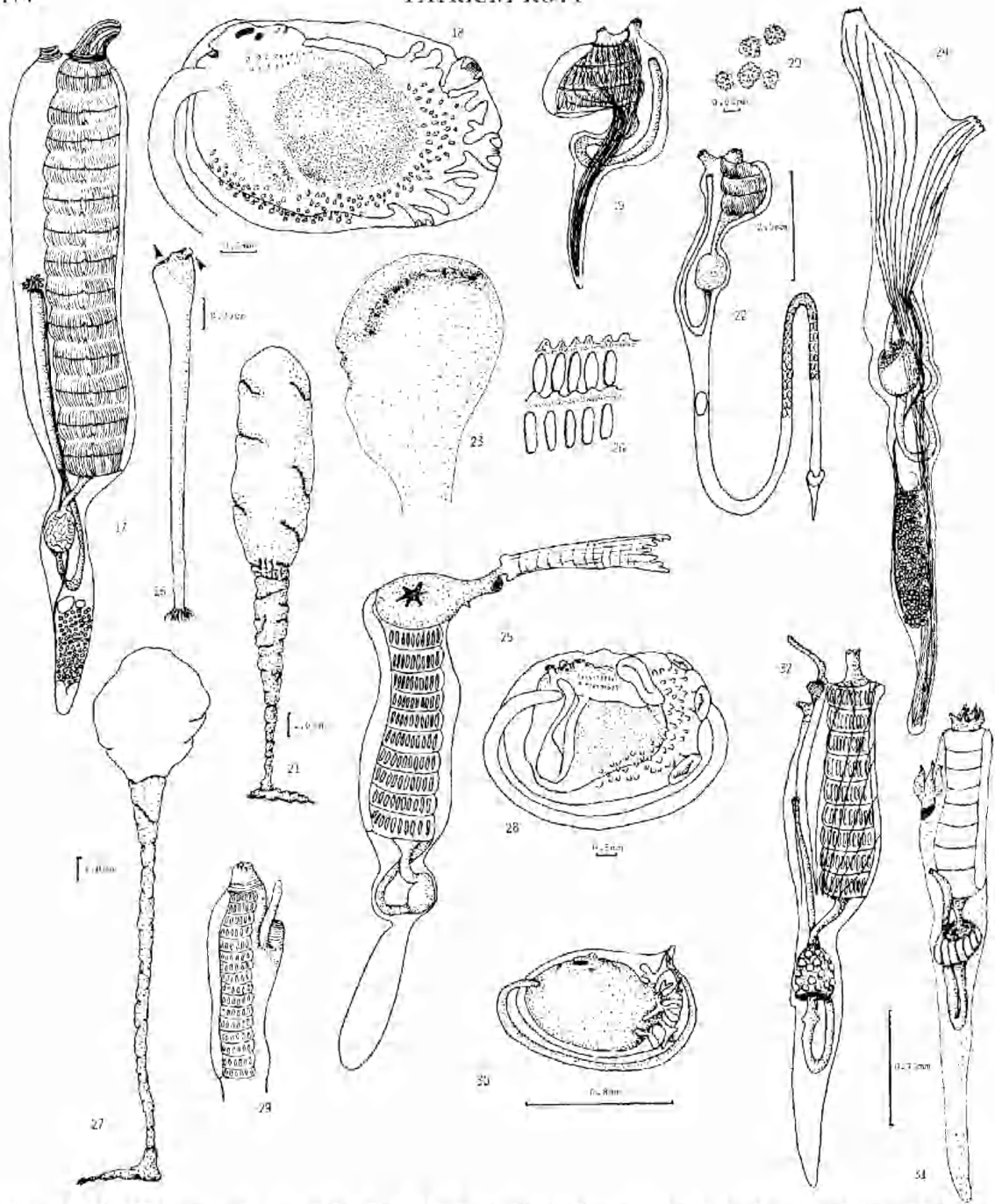
The present colonies from Waldegrave I. are long, with a long stalk and head, while those from Elliston Bay are no more than 2 cm high with a round soft head on a short thick stalk. This range in the form of the colonies has been observed in specimens from New Zealand (see *Sigillinaria novae-zelandiae* Brewin, 1950, a synonym of the present species, and *P. cereum*; Brewin 1958).

***Placentela ellistoni* n.sp.**

Type Locality: Elliston Bay, inside caves, outside bar, 14.v.1971, *Shepherd*. **Holotype:** SAM, E901. **Paratypes:** SAM, E900.

FIGS. 23, 24

Description: The colonies form narrow, fan-shaped lobes, rounded at the free edge and narrowing to the base. The lobes are 5 cm tall



- Figs. 16-18. *Euherdmania australis*. Fig. 16.—Individual. Fig. 17.—Individual removed from test. Fig. 18.—Larva.
- Fig. 19. *Pseudodistoma australis*. Zooid.
- Fig. 20. *Pseudodistoma cyrusense*. Spicules from test.
- Figs. 21, 22. *Pseudodistoma cereum*. Fig. 21.—Colony. Fig. 22.—Zooid.
- Figs. 23, 24. *Placentella ellisoni*. Fig. 23.—Colony. Fig. 24.—Zooid.
- Figs. 25, 26. *Polyclinum neptunium*. Fig. 25.—Individual. Fig. 26.—Portion of branchial sac showing papillae produced from transverse vessel.
- Figs. 27, 28. *Aplidium coelestoides*. Fig. 27.—Colony. Fig. 28.—Larva.
- Fig. 29. *Aplidium pantherinum*. Thorax.
- Fig. 30. *Aplidium flavineatum*. Larva.
- Fig. 31. *Aplidium elatum*. Zooid.
- Fig. 32. *Synoeicum papilliferum*. Zooid.

and about 2.5 cm broad across the free end, which is the widest part of the colony. There are sand-covered swellings projecting back from the rounded free border of the fan, and overlapping both sides of the colony. The test is very stiff and sandy. Branchial apertures are arranged in an arc protected by the overlap from the rounded free border of the fan. Each aperture is sessile and in a sand-free area of test. The atrial apertures on the opposite side of the colony are in a groove slightly further back than the corresponding arc of branchial apertures. Each atrial aperture is on a small mound and, as with the branchial apertures, is covered by the overlapping rim of the rounded free border of the fan. Zooids are arranged in only a single layer at the top of the colony but as they extend down towards the base, they overlap and cross one another and here the colony is narrower but thicker to accommodate the posterior ends of the zooids. The 6 lobes around both apertures are minute and very pointed. There is a mesh-work of circular and longitudinal muscles on the thorax, extending up around the siphons. There is a wide muscle band on the left side of the abdomen and on the dorsal side of the posterior abdomen, formed by very fine longitudinal bands from the thorax which all cross to the left side of the body across the postero-ventral part of the thorax. There are 17 rows of about 35 rectangular stigmata. The oesophagus is very short and the stomach is smooth and shield-shaped. The abdomen is only about half the length of the thorax. The posterior abdomen is of similar length and contains a large number of male follicles bunched together posterior to the ovary. It appears from the specimens examined that the branchial aperture may be contracted back along the ventral surface of the thorax so that the atrial siphon is terminal. Thus, by virtue of the strong body musculature, the whole top rim of the colony probably moves up and down or from side to side according to whether the arc of branchial apertures or the arc of atrial apertures is to be opened or whether both are simultaneously to be opened or closed.

Remarks: The species is unusual and although the arrangement of zooids within the colony resembles that found in *Ritterella herdmania*, the zooids themselves are distinguished by their strong thoracic musculature, by the smooth stomach (which resembles the type found in the genus *Synoicum*), and by the large number of rows of stigmata.

Subfamily POLYCLININAE

Polyclinum neptunium Hartmeyer, 1912: 331.
Kott, 1963: 83 and synonymy.

New Records: Elliston Reef, Elliston Bay.
Previous Records: W. Aust. (Shark Bay to Albany)—Michaelsen 1930; Kott 1963, S. Aust. (Reevesby I.)—Kott 1963. South Africa—Hartmeyer 1912; Millar 1962.

FIGS. 25, 26

Description: Colonies of large investing sheets or sessile, almost hemispherical, lobes, 4 mm high in thickest part and from 2 cm in diam. There is a dense sandy coat externally, absent only where branchial apertures open to the exterior. The common cloacal apertures are present on the surface, on or at the side of slight rounded elevations. Zooids are in round, to elongate or long, double row systems along either side of shallow, narrow, common cloacal canals. There is no sand in the internal test, which is semi-transparent and soft but tough. There are sometimes, but not always, black spherical pigment cells in the body wall, especially in the atrial languet and around the branchial aperture. There are 6 small, very pointed branchial lobes. The atrial languet, rising from above the sphincter muscle, may be pointed or long and with a flat terminal border fringed with up to 7 minute, pointed, lobes. The shape of the atrial languet is associated with the location of the zooid in relation to the cloacal canals or with the common cloacal openings, and its tip may be incorporated in the border of the opening. There may be a minute papilla from the body wall below the aperture. There are 6 parallel, longitudinal muscle bands in the atrial languet although these may coalesce or divide at any point along their length. These are crossed by very fine transverse muscles. There are 10 longitudinal muscles radiating from the siphons and extending down the thorax, although they may be difficult to detect in the posterior half of the thorax. There are 10 rows of 16 stigmata and a similar number of flat, rounded lobes, confluent at their base, supported along the transverse vessels. The stomach is small and smooth externally but with glandular papillae internally. The posterior abdomen is long and tongue shaped.

Remarks: The relationships of species within this genus have always been difficult to determine, owing to the homogeneity of the zooids and variability of the colony form and atrial languets. The present specimens have been identified by the relatively large number of

branchial papillae, by which the species is distinguished from *P. macrophyllum* (see Michaelsen 1930). There are also fewer rows of stigmata than in *P. macrophyllum*, although the number of stigmata in each row is greater. The internal test is also tougher than is usual for this genus.

Aplidium lobatum Savigny, 1816: 182. Kott, 1963: 97 and synonymy. Tokioka, 1967: 22.

New Record: Elliston Bay. *Previous Records:* see Kott 1963; Van Name 1954.

Description: Specimens are almost spherical and 1 cm in diam. The lower half is sandy and there is a more or less flattened upper surface through which the orange zooids are clearly seen through the transparent test. Sparse sand is present throughout the remainder of the test. The zooids are very small, with a fleshy tripartite atrial languet from the upper border of the opening. There are 6 rows of about 10 stigmata and 5 pronounced stomach folds.

Remarks: The small zooids, the atrial aperture, the small number of stigmata and 5 stomach folds characterise the species.

Aplidium cololoides (Herdman). Kott 1972a: 15 and synonymy.

New Records: off Waldegrave I., Investigator Strait (Stn. Y21). *Previous Records:* see Kott 1972a.

FIGS. 27, 28

Description: There is a rounded, firm, gelatinous head supported by a tough leathery stalk about 17 cm long. Zooids are minute and arranged along both sides of narrow, branching, longitudinal canals. Large common cloacal openings are randomly distributed over the head. The languet from the anterior border of the atrial aperture is very small and pointed. There are 16–18 rows of 10 elliptical stigmata and 15 stomach folds. In the present specimens, there are 2 embryos contained in the posterior part of the peribranchial cavity. One is almost mature while the other is at an early stage of development. This difference in the stage of development of the embryos is observed in all the zooids in which embryos are present.

Larvae: Mature larvae are large, 1.5 mm long. There are small, crowded, epidermal vesicles projecting from the anterior part of the larva around the base of the papillae, and extending along the ventral surface.

Aplidium pantherinum (Sluiter). Kott, 1963: 98 and synonymy.
Psammnaplidium pantherinum Sluiter, 1898: 26.

New Record: Elliston Bay. *Previous Records:* W. Aust. (Rottnest I. to Hamelin Bay)—Kott 1963. S. Africa—Sluiter 1898; Millar 1955, 1962.

FIG. 29

Description: The colony is oval in outline, 2 cm thick and 5 cm long. It is fixed by a small part of its base. The base and walls are even and sandy. The surface is marked off into irregularly circular depressed areas that are often free of sand. These are about 5 mm in diam. and are separated from one another by raised sandy ridges about 0.5 cm wide which form a network over the surface and sharply overhang the periphery of the depressed areas. Common cloacal apertures are present in the centre of these depressed areas, and are surrounded by the branchial openings of the zooids. There is sand enclosed throughout the otherwise gelatinous test, thus creating a rather hard colony. Zooids are minute and crowded and radiate down into the base of the colony. The branchial aperture is surrounded by 6 well-defined lobes. The atrial aperture is on a muscular siphon from about half way down the thorax, protected by a long, pointed, lip rising from the body wall anterior to the siphon. The thorax is muscular with a well developed circular sphincter muscle at the base of the branchial aperture. There are about 20 very fine longitudinal muscle bands on the thorax. There are 16 rows of 6 stigmata. The abdomen is about the same length as the thorax, with the small stomach half way down the abdomen. The stomach wall has 5 distinct folds.

Remarks: The form of both colony and zooids is unusual, but does resemble *Aplidium cratiferum* Sluiter, 1909; Van Name, 1918, from the Philippines, which is distinguished however by its 10–12 stomach folds.

Aplidium rubricollum Kott, 1963: 103; 1972a: 15.

New Record: Pearson I. *For Previous Records, Description,* see Kott 1972a.

Aplidium flavolineatum (Sluiter). Kott, 1963: 105 and synonymy.

Amaroucium flavolineatum Sluiter, 1898: 30.

New Records: Elliston Bay, off Waldegrave I. *Previous Records:* W. Aust., S. Aust., Vic., N.S.W.—Kott 1963. S. Africa—Sluiter 1898; Michaelsen 1934; Millar 1955; Tokioka 1959.

FIG. 30

Description: The colonies form low, rounded, cushions about 1 cm high and 1 cm in diam., with a sandy basal half sometimes narrowed to a short thick stalk. In the preserved specimens the zooids are orange, and open onto the transparent upper surface. They are arranged in circular to oval systems of 5–12 zooids. There may be some sand in the surface test between the systems. There are 3 pointed languets from the upper border of the atrial opening. There are about 20 longitudinal muscles on the thorax, continuous along both sides of the abdomen and posterior abdomen. There are 10–15 rows of 12–15 stigmata. The stomach is small and rounded with about 25–30 very narrow folds, slightly oblique and extending anteriorly toward the mid line on both lateral and mesial aspects of the stomach. The abdomen and posterior abdomen are of equal length, although the thorax is smaller. Zooids are very small and usually do not exceed 4 mm.

Larvae: These are present in the peribranchial cavity. They are 0.8 mm long and the tail winds three-quarters of the way around the body. There are median ampullae between the 3 suckers with lateral branches from the base of each median ampulla. The median ampullae are not always paired as they have been described previously, nor are there posterior vesicles. There has been some variation observed in the form of this larva however (see Kott 1963) and the differences are not thought to be significant.

Aplidium elatum n.sp.

Type Locality: Elliston Bay, outside bar, very strong surge, 17 m, 12.I.1971, *Shepherd*. *Holotype:* SAM E906. *Paratypes:* E905.

FIG. 31

Description: The colonies form tall, undulating, fan-shaped, flattened lamellae and lobes which are sometimes fused. Each lamella is a maximum of 1 cm thick. The maximum height from the base to the free rounded border is 6 cm. The surface is sandy but marked off into slightly prominent, rounded, swellings corresponding to the anterior ends of the minute zooids, which open on both surfaces and on

the free edge of the lamellae. The test is sandy throughout and the colony firm and hard. Common cloacal apertures are present from place to place over the surface and zooids are arranged in double rows radiating from them. The zooids and especially the anterior part of the thorax and the endostyle are orange in the preserved specimens. Zooids are about 3 mm long. The thorax and posterior abdomen are of about equal length and slightly longer than the abdomen. The branchial aperture is terminal with 6 sharply pointed lobes. The atrial aperture is opposite the 4th–6th row of stigmata and its anterior lip is produced into 3 almost foliated lips. These are not always of equal size, but they are always very muscular with longitudinal bands extending along their length. There are about 12 fine longitudinal thoracic muscles. There are 8 rows of 8 stigmata. The stomach is very short with about 15 distinct folds.

Remarks: The colonies are very like *Aplidium solidum* (Herdman) (see *A. arboratum* Kott nom. nov. 1963). The species differ however in the number of stomach folds, in the length of the posterior abdomen, and in the length and form of the atrial languets. The colony and the atrial lobes are similar to those of *A. sarasinorum* Millar, 1962, from S. Africa. However, the body musculature and stomach folds differ. *Aplidium multiplicatum* (see Kott 1963) forms jelly-like to firm, investing, colonies and has minute zooids, a branchial sac resembling that of the present species and about the same number of stomach folds. Again, however, the muscular large atrial languet and dense sand inclusion, distinguish the present species.

Synoicum papilliferum (Michaelsen). Kott, 1972a: 16 and synonymy.

New Record: Waldegrave I. *Previous Records:* see Kott 1972a.

FIG. 32

Description: The colony is rounded, lobed and branched. The diameter of a single lobe is about 1.0 cm. The zooids are parallel to one another and at right angles to the surface all around the colony, which does not appear to be fixed. There is a sparse coating of sand grains on the surface and throughout the test. The atrial aperture is on a short muscular siphon and protected by a long pointed lip which is produced from the anterior border of the opening. There is the usual protuberant papilla from the body wall posterior to the atrial siphon. There are 8 fine longitudinal

muscles on the thorax and there are 9 rows of 10 stigmata. The stomach is the usual shield-shape and has mulberry-like glandular swellings.

Remarks: The form of the atrial siphon, the papilla and the stomach with its mulberry-like swellings are characteristic of the species.

Family DIDEMNIDAE

Trididemnum cerebriforme Hartmeyer, 1913: 139. Kott, 1962: 275 and synonymy.

New Records: Elliston Bay, Investigator Strait (Stn. X17). *Previous Records:* see Kott 1962.

FIG. 33

Description: There are very extensive posterior abdominal common cloacal cavities and secondary common cloacal canals at the thoracic level. There is a very thin basal layer of test. Zooids are suspended between the basal and surface layer of test by pillar-like strands in which the abdomina are embedded, and through which the thoracic secondary cloacal canals extend. Spicules are sometimes evenly distributed throughout the test although they may be thick in the surface layer but sparse below thoracic level. They are large, 0.03–0.06 mm in diam. with 5–7 conical pointed rays in optical transverse section. Zooids have a minute thorax, with 3 rows of stigmata and a wide atrial opening. There are $7\frac{1}{2}$ coils of the vas deferens around a single testis follicle.

Remarks: The species is identified by the extensive posterior abdominal cloacal system and by the open atrial aperture rather than a posteriorly directed siphon, usually associated with this type of cloacal system.

Trididemnum spiculatum Kott, 1972a: 16.

New Record: Elliston Bay. *Previous Records:* see Kott 1972a.

FIG. 34

Description: The colonies are white and invest stalks and leaves of seaweeds. Deep primary cloacal canals extend around clumps of zooids but the secondary canals remain at thoracic level. There is a long lateral organ. There are 3 rows of stigmata and $5\frac{1}{2}$ coils of the vas deferens around a single testis follicle. The spicules are stellate, with 5–7 rays in optical section, 0.01–0.03 mm in diam.

Remarks: The smaller stellate spicules and the absence of a large posterior abdominal cloacal cavity distinguish the species.

Polysyncrator magnilarvum Millar, 1962: 165.

New Record: Investigator Strait (Stns X15, Y6). *Previous Records:* Natal—Millar, 1962.

FIG. 35

Description: The colonies are irregularly lobed, large and fleshy, and are supported by a very short and relatively narrow stalk. Each lobe may be up to 2 cm in diam. and a maximum of 2.5 cm in length. There are no spicules. There is a surface layer of bladder cells and beneath this some pigment cells which become less frequent internally although they congregate around inclusions and parasites in the test. The zooids are confined to a thin layer of surface test about 1 mm thick, and the centre of each lobe consists of gelatinous, firm, test without zooids. The consistency of the colonies varies from firm and gelatinous to hard and tough, but it is thought that this may reflect the preservation of the specimens. Common cloacal apertures are randomly placed over the surface and zooids are arranged on either side of long cloacal canals radiating from the apertures. The surface of the colony is marked by these long branching canals in the surface layer of test. The zooids are minute and have a long oesophageal neck. The thorax is especially small, 0.5 mm long. The branchial aperture has the usual 6 pointed lobes and there is a wide, open, atrial aperture. There are 4 rows of 6 stigmata. There are 8 testis follicles with $2\frac{1}{2}$ – $5\frac{1}{2}$ coils of the vas deferens. The ventral surface of each zooid is embedded in the common test so that the surface of the preserved colony is marked into small rounded mounds surrounded by a narrow depression where the thin surface test is depressed over the common cloacal canal to which the atrial apertures are exposed.

Remarks: The species is distinguished by its fleshy colony and by the large number of testis follicles and small number of vas deferens coils. *Polysyncrator aspiculatum* Tokoida, 1949, forms flat investing colonies and is often without spicules, but has a long bifid atrial lip which is absent in the present species.

Polysyncrator paradoxum Nott, 1892: 318.

New Record: Elliston Bay. *Previous Record:* New Zealand—Nott 1892.

Description: The living colonies are brilliant orange but in the preserved specimens only streaks of orange remain on the surface. There

are stellate pigment cells scattered amongst the spicules. There is a surface layer of bladder cells, then a dense layer of spicules which become less dense in the oesophageal region of the zooids and are absent completely from the test at the abdominal level and in the basal test. The common cloacal canals are very shallow and thoracic. There are 8 stigmata per row. There are 5 testis follicles and the vas deferens coils $6\frac{1}{2}$ times around them. The spicules are stellate, 0.01–0.03 mm in diameter.

Remarks: *P. paradoxum* var. *mahenum* Michaelsen, 1920, from the Seychelles probably represents a distinct species since it has only $2\frac{1}{2}$ coils of the vas deferens and the spicules have 24 points in optical section. The shallow thoracic common cloacal system and the arrangement of the spicules beneath the superficial bladder cell layer is characteristic of the present form. Owing to the very shallow thoracic common cloacal space, the colony is especially firm.

Didemnum candidum Savigny, Kott, 1972a; 19 and synonymy.

New Record: Elliston Bay, **Previous Records:** see Kott 1972a.

Description: The present colonies have the usual dark-brown zooids with brownish-black pigment cells. The surface test is thin but the basal test is slightly thicker. The cloacal system is thoracic although the primary canals may extend more deeply. The thorax of each zooid is enclosed in its own test sheath as it crosses the common cloacal space. There is sometimes a lateral organ near the posterior end of the thorax. There are $8\frac{1}{2}$ coils of the vas deferens around the single undivided testis follicle. Dense spicules are present throughout. They are 0.03–0.05 mm in diam. and show the characteristic range from burr-like to stellate. Vesicular cells previously described for *Polysyncraton orbiculatum* (see Kott 1972a) are present in circles around the branchial apertures.

Remarks: The pigmented zooids and form of the cloacal cavity, and the single testis follicle with a large number of vas deferens coils around it, have been used to identify this species. The presence of the vesicular cells previously thought to be diagnostic of *P. orbiculatum* is puzzling. However, although they have not previously been described for *Didemnum candidum*, they have previously been found randomly distributed over the surface of *Didemnum moseleyi* (see Kott 1972a).

Didemnum moseleyi (Herdman), Kott, 1972a; 19 and synonymy.

New Records: Elliston Bay, Emu Bay (Kangaroo I.), Investigator Strait (Stns. X7, 27, Y?). **Previous Records:** see Kott 1972a.

Description: The colonies are of the usual form with dense white stellate spicules, shallow thoracic common cloacal cavity, and large lateral organs. Living specimens from Waterloo Bay are yellow-orange, encrusting red algae.

Didemnum patulum (Herdman), Kott, 1972a; 18 and synonymy.

New Record: Emu Bay (Kangaroo I.). **For Previous Records, Description,** see Kott 1972a.

Remarks: The colony forms a large investing sheet marked with the usual blue grey lines to give a marbled appearance.

Didemnum ternatanum (Gottschaldt), Kott, 1966: 287 and synonymy. Tokioka, 1967: 77.

Didemniodes ternatanum Gottschaldt, 1898: 648.

New Record: Elliston Bay, **Previous Records:** see Kott 1966; Tokioka 1967.

FIG. 36

Description: The living colony is bright orange, although this is lost in preservative. The spicules are small and spherical with many very short conical spines projecting from the surface, 0.02–0.03 mm in diam. and very dense throughout the test. The surface of the colony is raised into mounds and ridges with common cloacal apertures on the apex of the thickenings. The primary cloacal canals extend almost to the basal test and usually are posterior abdominal, while there are thoracic secondary canals. Zooids occur in large clumps anchored to the basal test by solid test material in which the abdomina of the zooids are embedded, while in the thoracic region there are separate test sheaths enclosing each zooid and continuous with the surface test. The surface test is fairly thick. The mounds that are apparent on the surface of the test are therefore created by the great proliferation of zooids in these areas, between the primary cloacal canals. There are $5\frac{1}{2}$ coils of the vas deferens around a single testis follicle. There is a long, oval lateral organ on each side of the thorax. The branchial siphon is fairly long with distinct circular muscles.

Remarks: Although the common cloacal cavity in these specimens is not as well developed

as has been previously described for the species, the small spherical spicules help to distinguish it. Kott (1972b) was not able to identify a "yellow crustose" specimen of the family Didemnidae from West I. (near Penguin Rock). Although the gonads were not mature in the West I. specimen it has been compared with the present colonies from Elliston and is identical in every respect. In particular, the cloacal system and the distribution and form of the spicules are identical.

Leptoclinides reticulatus (Sluiter). Kott, 1972a: 18 and synonymy.

New Record: Investigator Strait (Stn. Y6).

Previous Records: see Kott 1972a.

Description: Spindle and stellate, purple and orange, pigment cells are present in the surface layer of test. Common cloacal openings are frequently and evenly distributed over the surface. The common cloacal system is extensive at the oesophageal and posterior abdominal level. The zooids are of the usual form with a posteriorly directed atrial siphon.

Leptoclinides fungiformis n.sp.

Type Locality: Outside Pearson I., on gravelly bottom mostly attached to shell or rock fragments, 9.i.1969, 50 m, *Shepherd*.
Holotype and Cotype: SAM, E911.

FIGS. 37, 38

Description: Two specimens are available from the type locality. They are about 6 cm high with a rounded head. There is a single cloacal aperture terminally. There is a thick dense layer of spicules in the surface test at the level of the branchial siphons. Spicules are less dense elsewhere in the head. In the stalk, the spicules are more evenly and densely distributed throughout. There is no surface layer of bladder cells. The test is firm but not tough. The test in the stalk is similar in consistency but is perforated by longitudinal spaces. The primary cloacal system consists of extensive cavities posterior to the superficial zooid layer surrounding a central core of test. Secondary canals receive the openings of the posteriorly directed atrial siphons and open into the primary cloacal cavity. Zooids open to the surface of the colony by a 6-lobed aperture. The atrial apertures are posteriorly directed from the posterior third of the thorax and have distinct circular muscle bands forming a sphincter. A circular sphincter muscle is present on the branchial siphon, but is not quite so apparent. There are also fine longitudinal

muscles on the thorax. There are 4 rows of about 8 stigmata on each side of the thorax. Eggs are large. The testis follicle is apparently undivided and the vas deferens is wound around it. The stomach is small and rounded. The zooids in these colonies are budding from the oesophageal region. Embryos are present in a layer beneath the zooids, but none were sufficiently mature to discern their form. The posteriorly directed atrial siphons open into the secondary cloacal canals rather than directly into the common cloacal chamber.

Remarks: Spicules are stellate and are fairly large. Although closely related to *Leptoclinides kingi* in the development of the cloacal system, the present species is distinguished by its larger spicules and smaller zooids, by the single testis follicle and by the smaller intestinal loop. The present species is further distinguished by its well developed stalk. No other stalked species of *Leptoclinides* has previously been described.

Suborder PHLEBOBRANCHIA

Family ?

Records: As well as the species of this suborder listed below, specimens of an undescribed colonial species have been taken from stations Y18, Y19 and from two other locations, all in Investigator Strait. The species will be described and its phylogeny discussed in a subsequent publication (Kott, in press (1)).

Family ASCIDIIDAE

Ascidia thompsoni Kott, 1972a: 27.

New Record: Elliston Bay. *Previous*

Records: see Kott 1972a.

Description: Individuals are the usual oval, laterally flattened shape, lying mostly on the left side. The body is pinkish and shows through the firm translucent test. There are no muscles on the left side of the body. Body musculature is present as an irregular network on the right or upper side of the body, stopping abruptly at the endostyle, and no muscles were detected on the left side of the body. There is not a row of short parallel bands around the ventral and dorsal border as in *A. sydneyensis*. The peritubercular area is very shallow. The dorsal lamina is double in its anterior part and is ribbed on the left side only. The branchial sac is simply folded between each longitudinal vessel and there are simple papillae at the junction of the longitudinal and transverse vessels.

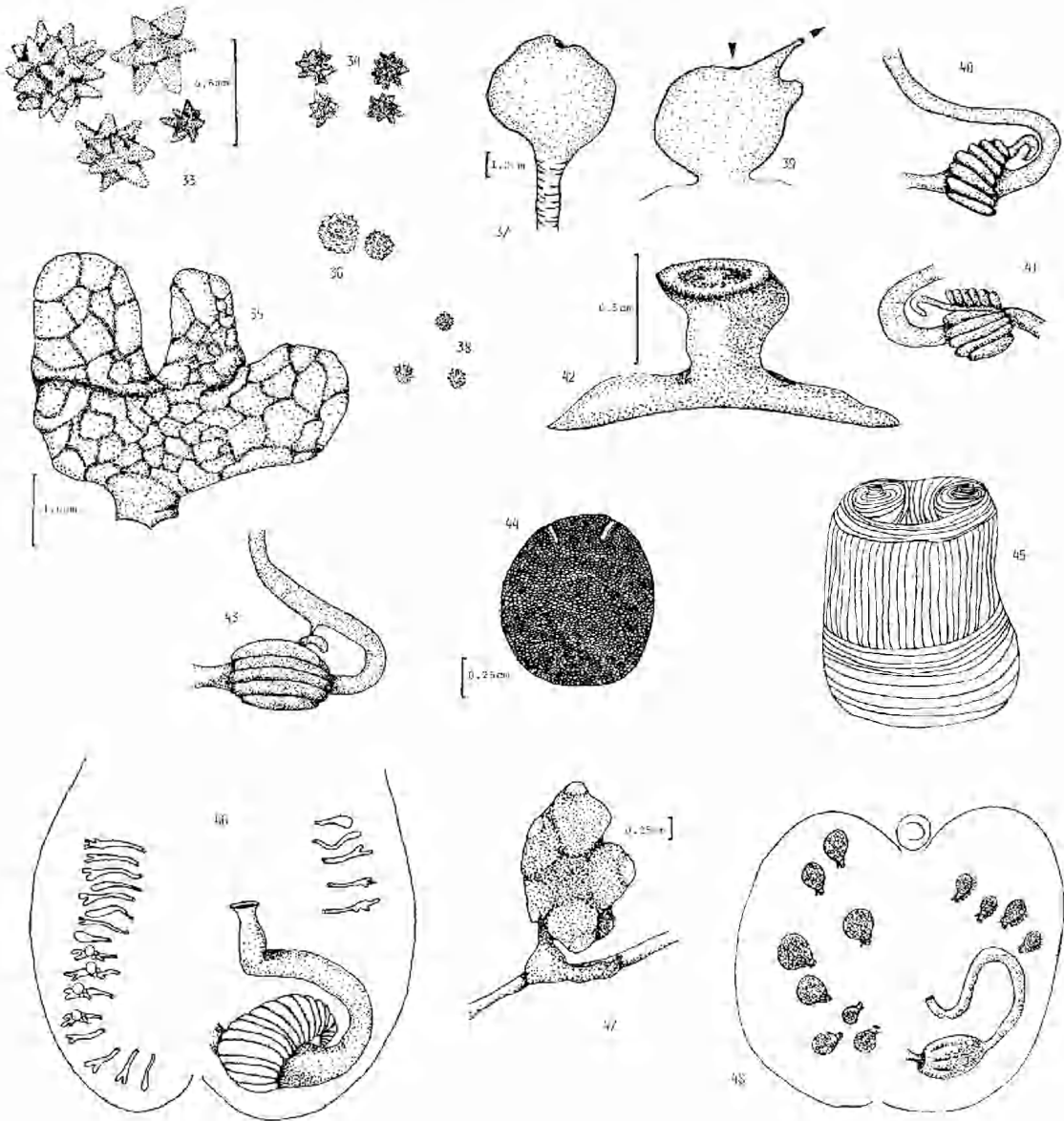


Fig. 33. *Trididemnum cerebriforme*. Spicules.

Fig. 34. *Trididemnum spiculatum*. Spicules.

Fig. 35. *Polysyncraton magnilarvum*. Colony.

Fig. 36. *Didemnum ternatanum*. Spicules.

Figs. 37, 38. *Leptoclinides fungiformis*. Fig. 37.—Colony. Fig. 38.—Spicules.

Figs. 39–41. *Metandrocarpa indica*. Fig. 39.—Individual. Fig. 40.—Mesial aspect of stomach. Fig. 41.—Later aspect of stomach.

Fig. 42. *Symplegma arenosa*. Individual.

Fig. 43. *Stolonica australis*. Gut loop and stomach.

Figs. 44–46. *Stolonica truncata*. Fig. 44.—Individual. Fig. 45.—Body removed from test to show body musculature. Fig. 46.—Gut, gonads.

Figs. 47, 48. *Polyandrocarpa simulans*. Fig. 47.—Colony. Fig. 48.—Gut, gonads.

Remarks: The present species is distinguished by the condition of the dorsal lamina and the body musculature.

Ascidia sydneyensis Stimpson: Kott, 1972a: 24 and synonymy.

New Records: Elliston Bay. Investigator Strait (Stn. Y18). For *Previous Records*, *Description*, see Kott 1972a.

Order PLEUROGONA

Suborder STOLIDOBRANCHIA

Family STYELIDAE

Subfamily POLYZOINAE

Metandrocarpa indica n.sp.

Type Location: Investigator Strait (Stn. Y6), 23 m, scattered low reef with shell sand patches and strong surge, *Watson*. *Holotype:* NMV, H159. *Paratype:* NMV, H158.

FIGS. 39-41

Description: The colonies consist of sessile, round, laterally flattened, sandy individuals 5 mm in diam., fixed to a common basal stalk which sometimes expands into a wider membrane. The present colonies invest an algal stem. The zooids are close to one another but each is entire and separate and the tests do not adhere. The test is thin and fairly brittle with embedded sand. Both apertures are anterior and fairly close together. The branchial aperture is sessile and the atrial aperture is on a pointed siphon directed away from the branchial aperture. The body wall is very delicate and closely adherent to the test. It has a fairly close mesh of very fine muscle fibres continuous all over the body. The branchial sac has 4 internal longitudinal vessels on each side with 6-8 stigmata per mesh, crossed by parasigmatic vessels, and there are 9 such rows of stigmata. The gut forms a simple open loop across the posterior end of the body and the rectum is produced anteriorly toward the base of the atrial siphon. The stomach is large and has about 16 conspicuous stomach folds. There is a longitudinal ridge along the lateral aspect of the stomach, which continues to form a long curved caecum in the gut loop. On the posterior side of this longitudinal ridge, the stomach folds are parallel to it. The folds on the anterior aspect of the stomach, however, extend more obliquely and terminate against this caecal ridge so that they do not extend continuously from the pyloric to the cardiac

end of the stomach. The anal border is smooth. The dorsal lamina is plain. Unfortunately no gonads were detected.

Remarks: Species of the genus *Metandrocarpa* Michaelsen, 1922, have been described with 5-10 internal longitudinal vessels, and male and female gonads on both sides of the body. Although the present species has only 4 internal longitudinal vessels and the gonads are not developed, its stomach is similar to that found in *M. dura* (Ritter) and *M. michaelsoni* (Ritter & Forsyth) both from California (see Van Name 1945). In both these species the stomach has a longitudinal ridge continuous with the pyloric caecum and against which the stomach folds terminate. In other genera of Polyzoinae, e.g., *Alloecorpa*, *Theodorella* and *Polyzoa*, although there may sometimes be a small number of internal longitudinal vessels, the stomach is barrel-shaped with parallel longitudinal folds.

Symplegmia arenosa n.sp.

Type Location: Off Waldegrave I., *Shepherd*. *Holotype:* SAM, E904. *Paratype:* SAM E985.

FIG. 42

Description: The colonies are formed of sessile, sandy individuals, more or less pillar-shaped but laterally flattened, the zooids taller than their width. They are fairly closely placed but are entirely separate and arise from a sandy basal plate formed of a tangle of basal stolons. Both apertures are close together on the upper free end of the body in a circular, sand-free, area of very thin test. The rest of the test is encrusted with sand. When the zooids are contracted, the stiffer, sand-encrusted, test on either side of the apertures is drawn together across the openings which then appear to be depressed in a longitudinal slit on the upper surface. The body wall has strong muscles around the anterior part of the body, consisting of longitudinal bands radiating from both the siphons and short transverse bands extending across the mid line dorsal and ventral to both of the siphons. These short transverse bands (as in *Agnesia glaciana*; Kott 1969b) are instrumental in drawing together the protective test across the aperture. There are 4 internal longitudinal vessels on each side of the body and 15 rows of stigmata. These are not crossed by parasigmatic vessels. There are 6-8 stigmata in each mesh. The longitudinal muscles extend only about a third of the distance down the

body. The gut forms a very short loop across the posterior end of the body and the rectum is long and extends anteriorly toward the base of the atrial siphon. The stomach is short and barrel-shaped with about 14 longitudinal folds and there is a short straight pyloric caecum connected to the anterior limb of the gut loop by a divided ligament and blood vessels (see *Symplegma oceania* Tokioka, 1961). There is also a connective between the stomach and the intestine. Unfortunately no gonads are developed in the present specimens.

Remarks: Although the present species resembles *Metandrocarpa indica* in the presence of 4 internal longitudinal vessels in the branchial sac and in the shape of the body, it differs in the body apertures, the body musculature, the shape of the stomach and pyloric caecum, and in the length of the gut loop. In the present species, the stomach, as well as the number of internal longitudinal vessels, resemble the condition in the genus *Symplegma*; and in *Symplegma oceania* Tokioka, 1961, from Noumea, the arrangement of the pyloric caecum and its ligaments and the connective between the stomach and the intestine are identical with the present species. Although *Symplegma* spp. are not usually upright as in the present species, they are joined to basal stolons which form a mesh and cross one another and an upright form has been described once previously, viz: *Symplegma viride stolonica* Verrill (see Van Name 1945).

The condition of the apertures is very specialised and the disposition of the body musculature to serve the protective device described above has not previously been recorded in the family Styelidae, although similar mechanisms are developed in the families Agnesidae (see Kott 1969b) and Molgulidae (see Kott 1972b).

***Stolonica australis* Michaelsen, Kott, 1972a: 28**
and synonymy.

New Record: Elliston Bay. **Previous Records:** see Kott 1972a.

FIG. 43

Description: In colonies recently collected from Tipara Reef (Spencer Gulf), there is a single row of hermaphrodite gonads anteriorly on both sides of the body, but posteriorly there are rather irregular scattered series of simple testis follicles. There is some variation in the apparent shape of the stomach, from pyriform to barrel-shaped depending on the condition

of the body wall covering the cardiac end. The caecum is only of moderate size and curved.

***Stolonica truncata* n.sp.**

Type Location: 1 km north-west of Waldegrave I. on rocky bottom with sand patches, 23 m, 11.v.1971, *Shepherd*. **Holotype:** SAM, E893. **Paratypes:** SAM E894, E909.

FIGS. 44-46

Description: Colonies comprise rounded, sandy, individuals joined by basal stolons. Each individual is spherical, sessile, and about 1 cm in diam. The apertures are both anterior on the free end of the body, and are present in conspicuous transverse interruptions to the rather solid sand encrusted test, so that each aperture is surrounded by delicate, thin test which can be withdrawn and covered over by protective sand-strengthened lips. The body wall is fairly muscular, with longitudinal bands radiating from both siphons, extending over the rest of the body. There is a broad band of circular fibres around the anterior end of the body and associated with the protective closing mechanism described above. There are also circular fibres around the posterior end of the body. There are 3 branchial folds on the right and 3 on the left, although they all tend to fade out posteriorly, especially the most dorsal folds. The internal longitudinal vessels are arranged according to the following formula:

DL 0(10)5(9)5(6)6 E

There are 1½-2 stigmata per mesh, although these are set slightly obliquely in relation to the internal longitudinal vessels. The gut forms a simple transverse loop with the rectum turning slightly anteriorly. The stomach has a large number of very fine longitudinal folds, and the whole extent of the anterior border of the stomach is produced into a tube of gradually decreasing diameter, lined internally with glandular folds in parallel with those lining the rest of the stomach wall. This tube forms a curve in the gut loop and terminates in a pointed caecum. The anus is bilabiate. On the left hand side of the body, anterior to the gut loop, there may be 5-6 elongate and sometimes branching testis follicles, terminating distally in the long slender duct directed toward the atrial aperture. On the right hand side of the body, there are similar testis follicles arranged around the posterior half of the ventral border and around the posterior border of the body. Some of these testis follicles are also associated with an ovary

of 2-3 eggs, lying on the mesial surface of the distal end of the testis and opening by a short wide oviduct, while the seminal duct curves around and for most of its length lies free in the peribranchial cavity. There are up to 6 hermaphrodite gonads of this type in the centre of the row of gonads on the right side of the body. Larvae are present in the right peribranchial cavity. They have triradiate papillae and appear to be of the type generally associated with the Polyzoinae (see Millar 1960).

Remarks: The most unusual production of the anterior aspect of the stomach to form the long curved caecum in the gut loop is quite distinctive. The long branching testis follicles are also unusual, while externally the highly specialised device to protect the apertures, each located in a transversely oriented strip of unmodified test, by withdrawing them beneath the firm sand-hardened test is unique. Closing mechanisms as described above for *Symplegma arenosa* n.sp., and for species in the families Molgulidae and Agnesidae, usually involve both apertures simultaneously. The test is black and can be seen through the encrusting sand.

Oculinaria australis Gray. Kott, 1972a: 29 and synonymy.

New Record: Off Waldegrave I., Elliston Bay. For *Previous Records, Description*, see Kott 1972a.

Polyandrocarpa simulans n.sp.

Type Location: Investigator Strait (Stn. Y6, Y19), 23 m, on scattered low-reef with shell sand patches and strong surge, *Watson*. **Further Records:** Investigator Strait (Stn. Y19), Elliston Bay, St. Francis I. **Holotype:** NMV, H162. **Paratypes:** NMV, H160, H161, H163.

FIGS. 47, 48

Description: The colonies form tight aggregates of individuals about 1 cm in diam. The living specimens are reddish brown, tipped with black, although preserved specimens are black. The test is thick with a slight sand encrustation, although this is not present internally where the test of adjacent zooids is confluent. Both apertures are sessile. The branchial aperture is terminal and the atrial aperture anterodorsal. The body wall is very muscular, with almost continuous layers of longitudinal and circular muscle bands. The branchial sac has 4 low folds with crowded, very thick, internal longitudinal vessels. The transverse branchial

vessels are also thick so that the branchial sac is a very tough organ in this species. Longitudinal vessels are arranged according to the following formula:

E 1(6)1(9)1(8)1(9)0 DL

The body musculature is especially thick around the apertures. The gut forms a small closed loop in the posterior end of the body and the rectum extends forward to the atrial aperture to form a secondary loop. A round, flat-topped, endocarp completely occupies the primary gut loop as in *Polycarpa pedunculata*. The small, pear-shaped stomach has internal glandular folds. The anal border has 4 sometimes indented rounded lobes. The gonads are flat, flask-shaped ovaries opening by a short, wide, oviduct directed towards the atrial aperture and overlying two rows of testis follicles with 5-6 follicles in each row. The ducts of each testis follicle join a common duct that runs along each side of the ovary to join together and open into the peribranchial cavity on the mesial aspect of the short oviduct. The gonads are embedded in thick body wall. There are up to 5 of these gonads on the left side of the body, usually in a single row anterior to the gut loop. On the right, there are up to 9 gonads usually arranged in 2 rather irregular rows.

Remarks: This species is very reminiscent of *Polycarpa pedunculata*. In view of the tight aggregates and confluent test and the absence of sand between adjacent individuals, however, it is clear that colonies form by vegetative reproduction rather than by aggregation of a number of solitary individuals. The process of vegetative budding to form these colonies is probably associated with the small size of the mature individuals, thus limiting the number of internal longitudinal vessels in the branchial sac and the number of gonads on the body wall.

Polyandrocarpa lapidosa (Herdman). Kott, 1952: 250. Millar, 1963: 730.

Guodsiria lapidosa Herdman, 1899: 99.

New Record: Investigator Strait (Stn. Y19), *Previous Records:* Vic. (Port Phillip Heads, Westernport)—Millar 1963. N.S.W. (Port Jackson)—Herdman 1899; Kott 1952.

Description: The present specimen is a large, sandy, plate-like colony with the upper surface slightly concave, 9 cm in diam. with a maximum thickness of 2 cm, fixed by a large part of the basal surface. The surface of the colony is smooth and sandy without conspicuous

swellings or furrows. The zooids are long, but both openings are on the upper surface. There are 4 long branchial folds of very varying height and internal longitudinal vessels are arranged according to the following formula:

DL (10)1(3)1(7)1(4)1 E

The gut extends in a simple arc from the posterior end of the body to the anterior atrial aperture. There are 12 internal longitudinal stomach folds. The gonads are elongate and arranged along either side of the endostyle.

Subfamily BOTRYLLINAE

Botrylloides leachi (Savigny). Kott, 1972a: 29 and synonymy.

New Records: Elliston Bay, off Waldegrave I. For *Previous Records, Description*, see Kott 1972a.

Botrylloides magnicoecum Hartmeyer. Kott, 1972a: 30 and synonymy.

New Records: Waldegrave I., Pearson I. For *Previous Records, Description* see Kott 1972a.

Botryllus schlosseri (Pallas). Kott, 1972a: 31 and synonymy.

New Record: North of Waldegrave I. For *Previous Records, Description*, see Kott 1972a.

Subfamily STYELINAE

Styela plicata (Lesueur). Kott, 1972b: 239 and synonymy.

Ascidia plicata Lesueur, 1823: 5.

New Record: Coffin Bay. For *Previous Records, Description*, see Kott 1972b.

Styela pedata (Herdman).

Polycarpa pedata Herdman, 1881: 71, Tokioka, 1958: 322 and synonymy. Kott, 1964: 137.

Pandocia pedata Hartmeyer, 1909-11: 1360.

Styela whitelegii Kott, 1952: 213.

Tethyum whitelegii Hartmeyer, 1909-11: 1364.

New Records: Off Waldegrave I., Pearson I. *Previous Records*: N.S.W. (Port Jackson, Port Stephens, Port Curtis)—Herdman 1889; Kott 1952. Qld. (Moreton Bay, Great Barrier Reef)—Hastings 1931; Kott 1964. Indonesia—Pizon 1908. Philippines—Herd-

man 1881; Van Name 1918. Japan—Tokioka 1958.

FIGS. 49, 50

Description: The preserved specimen is orange, the test is tough and leathery, with longitudinal ridges without any foreign bodies attached. The body is of characteristic shape, expanded postero-dorsally. Both apertures are directed upwards and the branchial aperture, on a siphon continuous with the upright ventral surface, is often recurved. The atrial aperture is also on a short siphon above the postero-dorsal expansion of the body. Basally the test is extended into prop-like roots. The body wall is muscular. The dorsal tubercle is oval with numerous separate circular openings giving it a porous, sponge-like appearance.

Up to 21 internal longitudinal vessels are evenly spaced on the folds, and 3-7 internal longitudinal vessels are present between the folds. There are 6-8 stigmata per mesh. The gut forms a fairly wide loop with tall endocarps enclosed by the loop. The stomach is elliptical with longitudinal internal glandular folds. The anal border is lobed.

There are 3 branched and ramifying gonads on the left above the gut loop and up to 9 on the right. The gonads are embedded in and occupy most of the body wall except where the gut is present on the left. Tall endocarps are present over the body wall between the branches of the gonad. The gonads have testis follicles closely applied to either side of the ovary.

Remarks: The gonads and endocarps of this species are very similar to the much branched and ramifying gonads of *S. ramificata* Kott, 1952, which has also been recorded from Moreton Bay. *S. ramificata* is, however, a very much smaller species heavily encrusted with sand and shell, with a continuous V-shaped opening on the dorsal tubercle, a narrow gut loop and a longer rectum than in the present species. A similar dorsal tubercle is present in *Polycarpa aurata* (Quoy & Gaimard) (see Van Name 1918) which is also similar to the present species in other characters. It is distinguished mainly by its short, typically polycarp gonads in contrast to the long ramifying styelid gonads of the present species. *Styela pedata*, therefore, has a wide distribution from the Philippines and Japan and around the eastern seaboard of Australia to the Great Australian Bight. It overlaps with *P. aurata* in the Philippines and on the east coast of Australia.

Polycarpa tinctor (Quoy & Gaimard), Kott, 1964: 134 and synonymy.

Ascidia tinctor Quoy & Gaimard, 1834: 608.

New Record: Off Waldegrave I. **Previous Records:** see Kott 1964.

Description: A single specimen only is available. It is large and slightly damaged. The test, however, has the usual hard, brittle, sand-encrusted form characteristic of the species. The specimen is laterally flattened, with the atrial aperture half way down the dorsum. The apertures are sessile. The dorsal tubercle is large with a complementary slit. The branchial sac has 4 very narrow folds. Gonads were not detected in the present specimen.

Remarks: The present species had not previously been taken further south than Port Jackson. It does occur commonly on the north-west and north-east Australian coast, in the East Indies, and off Japan. The form of the dorsal tubercular slit, broken into several parts, has previously been described in specimens from Japan and the East Indies.

Polycarpa pedunculata Heller, Kott, 1972a: 35 and synonymy.

New Records: Elliston, N-W of Waldegrave I., 22 m off Waldegrave I., Pearson I., Investigator Strait (Stns. X9, 15, 19, 21, 25, 27; Y6, 12, 23; Z9, 11), Emu Bay (Kangaroo I.). For **Previous Records, Description**, see Kott 1972a.

FIG. 51

Remarks: Specimens in this collection demonstrate the full range in external appearance, from sessile to stalked individuals, from brownish to black individuals. In general, the stalk of specimens from Investigator Strait is longer than that found in specimens from St. Vincent Gulf, and many of the specimens are superficially very similar to specimens of *Pyura scoresbiensis* with which they occur, demonstrating convergence in their external appearance related to the environment.

Polycarpa clavata Hartmeyer, Kott, 1972a: 33 and synonymy.

New Records: Waldegrave I., 22 m off Waldegrave I., Pearson I., Investigator Strait (Sta. Y21). For **Previous Records, Description**, see Kott 1972a.

Family PYURIDAE

Pyura spinifera (Quoy & Gaimard), Michaelsen, 1922: 390 (part: Port Jackson specimens). Kott, 1952: 269; 1972a: 39.

Ascidia spinifera Quoy & Gaimard, 1834: 617.

Boltenia australiensis Carter, 1885: 197.

Boltenia tuberculata Herdman, 1891: 511; 1899: 17.

Cynthia multiradicata Herdman, 1899: 30.

Boltenia spinifera Michaelsen, 1905: 72 (part: not *B. gibbosa*).

Boltenia spinosa var. *intermedia* Michaelsen, 1908: 390.

Pyura gibbosa var. *intermedia* Michaelsen, 1922: 390.

Pyura australiensis f. *typica* Michaelsen & Hartmeyer, 1928: 410.

New Records: Off Waldegrave I., Investigator Strait (Stns. Y19, Z7). **Previous**

Records: W. Aust. (Albany)—Quoy & Gaimard 1834. S. Aust. (St. Vincent Gulf)—Kott 1972a. Vic. (Port Phillip Heads, Portland Harbour, Cape Woolami, Bass Strait)—Carter 1885; Michaelsen 1905. N.S.W. (Port Jackson)—Herdman 1899; Kott 1952.

FIG. 52

Remarks: Minute scale-like spines are present on localised ridges in the branchial siphon. The branched keratose fibres (see Carter 1885) and Michaelsen & Hartmeyer 1928) are present in the body wall and stalk. They are similar to spicules found in *Pyura stolonifera* (see Millar 1962). The specimens are invariably covered with a sponge (*Halisarca*; see Carter 1885).

Pyura australis (Quoy & Gaimard).

Pyura australis subspecies *australis* Kott, 1972a: 39 and synonymy.

Pyura australis var. *parvispinatis* Kott, 1952: 268.

Boltenia gibbosa Herdman, 1899: 19.

New Records: Off Waldegrave I., N.W. of Waldegrave I., St. Francis I., Pearson I., Investigator Strait (Stns. X27, Y21), Emu Bay (Kangaroo I.). For **Previous Records, Description**, see Kott 1972.

FIG. 53

Remarks: The principal character on which the distinction between the two subspecies, *P. australis typica* and *P. australis parvispinatis*, was based is the condition of the anal border. A careful examination has shown that in this group of species the terminal part of the rectal wall always has flat folds projecting into the

lumen as described for *P. australis parvispinatis* Kott, 1952. These folds are usually extended beyond the anal border into rounded lobes which are often long and finger like and sometimes subdivided. Occasionally, however, they do not extend outside the anal rim. There is no constant condition observed for any group of specimens in regard to the anal border and it is concluded that subspecies are not indicated. The slight difference in the length of the branchial spines (Kott 1952) is not significant. These are conical and only slightly curved and arise from a long oval base, 0.02–0.03 mm long, and their length along the spine is 0.02–0.04 mm. The largest spines are nearest to the apertures. Typical stellate spicules, 0.02 mm in diam., are always present in the test and siphonal lining and distinguish the species.

***Pyura pachydermatina* (Herdman) s.sp. *draschii* nom. nov.**

Boltentia pachydermatina Herdman, 1881: 81. Drasche, 1884: 370. Herdman, 1899: 16. ?Herdman & Riddell, 1913: 875.

Pyura pachydermatina var. *gibbosa* Kott, 1952: 265.

New Records: Waldegrave I., Elliston Bay. *Previous Records*: W. Aust. (Cottesloe to Albany), Vic. (Julia Percy I., Flinders, Walkerville)—Kott 1952. N.S.W. (Kiama, Port Jackson)—Drasche 1884; further specimens in Australian Museum.

FIGS. 54, 55

Description: Typical specimens with dumb-bell shaped spicules and fringed anal lobes. The siphonal spines are produced into a long pointed base which is distinct from the rounded base in *P. australis*, or the flattened scale-like base in *P. spinifera*. Michaelsen (1905, 1908, 1922) and Michaelsen & Hartmeyer (1928) attempted rationalisation of the relationships of the species *Pyura pachydermatina*, *P. gibbosa* and *P. spinifera* and their synonyms, on the basis of external appearance, condition of the stalk and of the dorsal tubercle, and the presence or absence of spicules. A study of the group in Australia has shown that the form of the spicules and siphonal spines, supported, within certain limits, by the form of the anal border, provides the only reliable character on which to distinguish the species. Michaelsen & Hartmeyer (1928) characterise *P. pachydermatina* by the presence of a smooth anal border, complicated dorsal tubercle, and dumb-bell shaped spicules. This is only true, however, for the New Zealand subspecies *P.*

pachydermatina typica since although the dumb-bell shaped spicules are always present, the Australian forms never have a smooth anal border. The dorsal tubercle may be a less complicated double spiral cone. Thus *Pyura gibbosa*: Michaelsen & Hartmeyer 1928 (type specimen: *Cynthia gibbosa* Heller, 1878, from Bass Strait) with anal lobes and dumb-bell shaped spicules falls within the definition of *P. pachydermatina* and Heller's specimen becomes the type of the subspecies *P. pachydermatina gibbosa* (not *P. pachydermatina* var. *gibbosa* Kott, 1952). *Pyura gibbosa intermedia* Michaelsen, 1922 (>*P. spinifera intermedia* Michaelsen, 1905) from Backstairs Passage, S. Aust., together with *P. spinifera typica* (part: *P. tuberculata* Herdman) from New South Wales, neither of which have dumb-bell shaped nor stellate spicules, are consequently synonyms of *P. spinifera*, rather than of *P. pachydermatina gibbosa*. *Pyura pachydermatina draschii* is distinguished from *P. pachydermatina gibbosa* (>*P. pachydermatina intermedia*; Kott 1952) (which has shallow anal lobes) by its fringed anal border. *P. Pachydermatina gibbosa* overlaps the present subspecies from Bass Strait to Port Jackson, and extends further to the north. The western limit for *P. pachydermatina draschii* is not at Walkerville, Victoria, as Kott (1952) had suggested, since it extends to Western Australia.

***Pyura scoresbiensis* Kott 1972a: 36.**

New Records: Pearson I., Investigator Strait (Stns. X9, 11, 15, 17, Y14). *Previous Records*: see Kott 1972a.

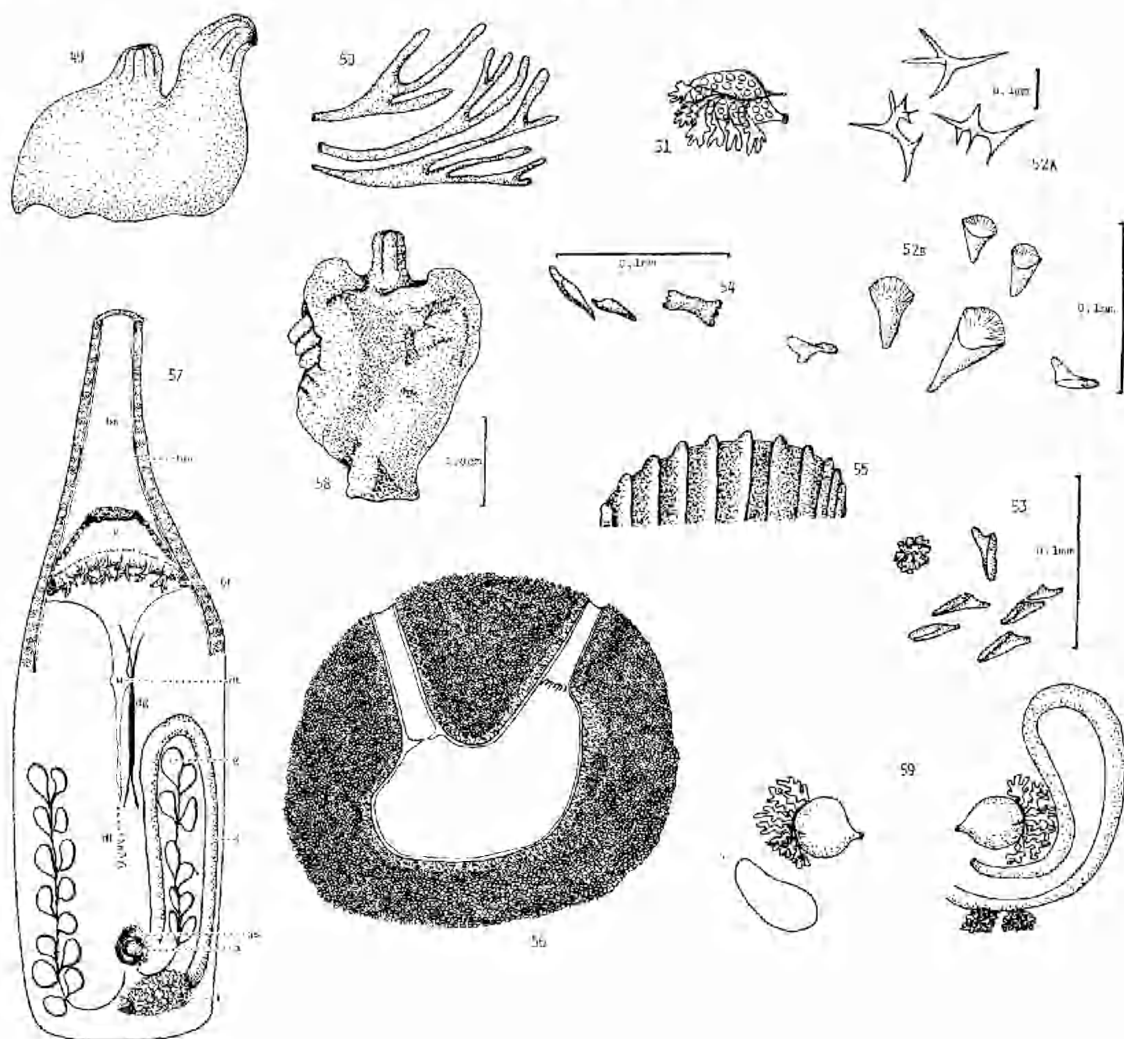
Description: Specimens available show a wide range in the length of stalk and in the development of the rooting processes at the base of the stalk. These sometimes form large sandy lamellae as the roots spread and sand adheres to them. The apertures are always close together on the upper surface, although the pronounced ridge between the apertures previously described (Kott 1972a) is not always present.

***Pyura irregularis* (Herdman), Kott, 1972a: 38 and synonymy.**

New Record: Investigator Strait (Stn. Y6). For *Previous Records*, *Description*, see Kott 1972a.

***Pyura tendata* n.sp.**

Type Location: Investigator Strait (Stn. Y21), 30 m, scattered, low, on pebble reef



- Figs. 49–50. *Styela pedata*. Fig. 49.—Individual. Fig. 50.—Gonads from left side of body.
 Fig. 51. *Polycarpa pedunculata*. Gonad showing flask shaped ovary and testis follicles.
 Fig. 52. *Pyura spinifera*. Fig. 52a.—Branching spicules from body wall. Fig. 52b.—Branchial spines.
 Fig. 53. *Pyura australis*. Spicule and branchial spines.
 Figs. 54, 55. *Pyura pachydermatina*. Fig. 54.—Dumbbell shaped spicule and branchial spines. Fig. 55.—Anal border showing internal folds from rectal wall.
 Figs. 56, 57. *Pyura tendata*. Fig. 56.—Longitudinal section to show sandy coating around body.—Fig. 57.—Body opened around ventral surface, branchial sac removed to show branchial velum, tentacles, dorsal ganglion, gut and gonads: branchial sac (bs); body muscles (bm); branchial velum (v), branchial tentacles (bt); dorsal tubercle (dt); dorsal ganglion (dg); dorsal lamina (dl); intestine (i); gonad (g); base of the atrial siphon (as); anal opening (a).
 Fig. 58. *Herdmania momus*. Individual.
 Fig. 59. *Molgula ellisoni*. Gonads, gut loop and kidney on inner surface of body wall.

with sand patches. *J. Wason*. Holotype: NMV, H156.

FIGS. 56, 57

Description: The species appears to occur in aggregates. The holotype, however, is the only complete specimen available and only small parts of at least two others were obtained when the specimen was broken from its substrate. The outline of the individual is not obvious superficially, since it is completely surrounded by a sandy coat 1 cm or more thick. The test is very thin, without wrinkles, and minute hair-like extensions of the test are seen extending across a narrow space between the sandy coating and the test. It is probably these hairs which enmesh the sand forming the thick coating around the body. The narrow space between the outer surface of the test and the sandy coating is occupied by various commensal worms and echinoderms.

The animal itself consists of a club shaped body narrowing to a long terminal branchial siphon. The atrial siphon is twice the length of the branchial siphon and extends forwards from the dorsal border of the body in the anterior part of the posterior third of the body length and opens level with the branchial opening. Excluding the sandy coat, the body is 1 cm deep from its dorsal border at the base of the atrial siphon to its ventral border. The length of the atrial siphon is 2 cm. Owing to the gradual narrowing of the body to the base of the branchial siphon, the body appears to have two long diverging siphons of equal length.

The body wall is very muscular. Branchial tentacles are present at the base of the branchial siphon half way between the external aperture and the base of the atrial siphon. Just anterior to the ring of branchial tentacles, which are 3 times branched, there is a large muscular velum protruding into the lumen of the branchial siphon. The dorsal tubercle is in the base of a very long narrow peritubercular area extending half way down the branchial sac. It is a very small, simple U. The elongate dorsal ganglion is associated with the base of the atrial siphon just posterior to the dorsal tubercle. There are 9 branchial folds with internal longitudinal vessels arranged as follows:

E (4)0(7)0(13)1(15)2(16)3(2)1(16)2(13)0(7) DL

The gut forms a simple loop in the posterior end of the body. There are minute, branched, liver tubules in the pyloric region and the body wall covering the distal portion of the

rectum is produced into a pronounced non-muscular atrial velum so that the bilabiate anus actually opens into the base of the atrial siphon beyond this velum. The branchial velum has very strong circular muscles in its basal half. The body musculature is very strong, with outer circular bands forming an almost continuous coat external to strong well-spaced longitudinal muscle bands. The gonads consist of about 7 or 8 pairs of polycarp-like sacs either side of central ducts in the gut loop on the left and in a corresponding position on the right side of the body.

Remarks: This quite extraordinarily modified species is in most essential aspects typically pygid and resembles *Pyura cancellata* Brewin (see Kott 1971) in the thick sandy coating created by sand enmeshed by the long test hairs all around the body. Its most conspicuous character is the very long atrial siphon and the narrowing of the anterior part of the body so that the branchial aperture is also produced upwards to a level with the atrial siphon, so that the incurrent ciliary stream is not obstructed by the sand being accumulated around the body. The thick, sandy coating is so dense and so rigid that it is hard to imagine how the animal is able to increase in size. It is probable, however, that the commensals present between the sandy coating and the test constantly irrigate this area and thus maintain the space into which the animal can expand as it grows. These commensals are therefore probably essential to such sand covered species (see also *Pyura cancellata*; Kott 1971).

Halocynthia hispida (Herdman). Kott 1968: 76 and synonymy; 1972a: 41.

New Record: Investigator Strait (Stn. X19).

For Previous Records, Description, see Kott 1968.

Herdmania momus (Savigny). Kott, 1972a: 41 and synonymy.

New Records: Off Waldegrave I., St. Francis I., Pearson I., Investigator Strait (Stn. X17), Spencer Gulf. **For Previous Records, Description,** see Kott 1972a.

Remarks: There is the usual great range in size of individuals. Smaller specimens are more or less upright with transparent test and short furrowed siphons. Larger specimens become laevis and opaque.

Ctenicella antipoda Kott, 1972a: 44.

New Record: Investigator Strait (label illegible). **For Previous Records, Description,** see Kott 1972a.

Remarks: The distal part of the gut loop is distended with mud. In one large specimen the gonads on the left side of the body are enclosed in the gut loop. In view of the agreement with the type specimen in all other aspects, this must be regarded as an individual variation.

***Molgula ellistoni* n.sp.**

Type Location: Elliston Bay, in caves outside bar, subject to strong swell, 14.v.1971.
Holotype and Paratypes: SAM, E907.

FIG. 59

Description: Small sandy spherical individuals were found adhering to *Euherdmania australis* and sometimes forming aggregates. Both apertures are present fairly close together on the upper surface and are directed away from one another. Very delicate muscles radiate out from the siphons. There are internal circular muscles around the branchial and atrial siphons. There are 7 branchial folds on each side of the body, with 6 meshes along each fold. Each mesh contains a primary spiral infundibulum, which subdivides into two half way up into the fold. There are 3 internal longitudinal vessels arranged along the fold. There is the usual long gut loop open at the pole and a short curved kidney on the right side of the body. The gonads consist of a circular ovary with a short, wide, duct directed dorsally. Testis follicles are present along the proximal border of the ovary and join into a very short vas deferens which opens into the peribranchial cavity on the mesial surface of the ovary. The right gonad is in the middle of the body wall and the left gonad is in the secondary gut loop. The specimens are about 0.5 cm in diam.

Remarks: The position and form of the gonads with the very short vas deferens opening on the surface of the ovary are distinctive. Atrial embryos are present in the peribranchial cavity.

***Molgula sabulosa* Quoy & Gaimard 1834: 613.**
Kott, 1972b: 248 and synonymy.

New Record: Elliston Bay. For Previous Records, Description, see Kott 1972b.

Characteristics of the Fauna

An outstanding feature of the fauna is the large number (23) of species in the relatively primitive Aplousobranchia. Polycitoridae, Claveliniinae and Euherdmaniinae, in which

common cloacal systems are not developed. A further 7 species are secondarily colonial species of Styelidae; one is a colonial phlebobranch species; three are aggregated pyurids; and there are two aggregated species of the family Molgulidae. Thus about half of the species present, although colonial in habit, preserve their own independent openings and do not form cloacal systems. They do, however, demonstrate remarkable morphological adaptations in the arrangement, orientation and operation of their apertures to maximise their reactions with the environment. Colonies of *Ritterella herdmania*, *Placentella ellistoni* n.sp., and the new colonial phlebobranch species are of special interest in that the zooids are arranged in parallel, so that their branchial and atrial apertures are respectively located on different sides or at different ends of the colony. Some benefit can accordingly be derived from mutual reinforcement of feeding currents. One would expect that the exact orientation of these colonies would be such that prevailing currents could also reinforce the incurrent and excurrent ciliary streams.

These species and many of the Claveliniinae, together with the new species *Metandrocarpa indica*, *Symplegma arenosa* and *Stolonica truncata*, all have specially adapted body musculature to operate sophisticated siphonal apparatus. Adaptation of the nervous system to serve the specialised musculature can also be expected. In fact, in both *Pyura tendana* and in the new colonial phlebobranch species, the neural gland and ganglion are located posteriorly in association with an unusual posterior position of the atrial siphon.

None of the species discussed above are encrusting and most favour habitats under ledges and in crevices or caves. There are only 18 species with highly evolved cloacal systems that have achieved a degree of independence of the environment and, with only 4 exceptions (*Didemnum candidum*, *D. moseleyi*, *Trididemnum spiculatum* and *Botryllus schlosseri*), these are also bulky or stalked (rather than encrusting) and favour habitats under ledges or in crevices or caves.

The majority of the solitary stolidobranch species that are present are stalked and able to maximise their reactions with the environment by moving on their stalk with the current. There are only few solitary bottom-living species (*Ascidia* spp., *Polycarpa tinctor*, *Ctenicella antipoda*) or large fixed species (*Herdmania momus*, *Styela pectata*).

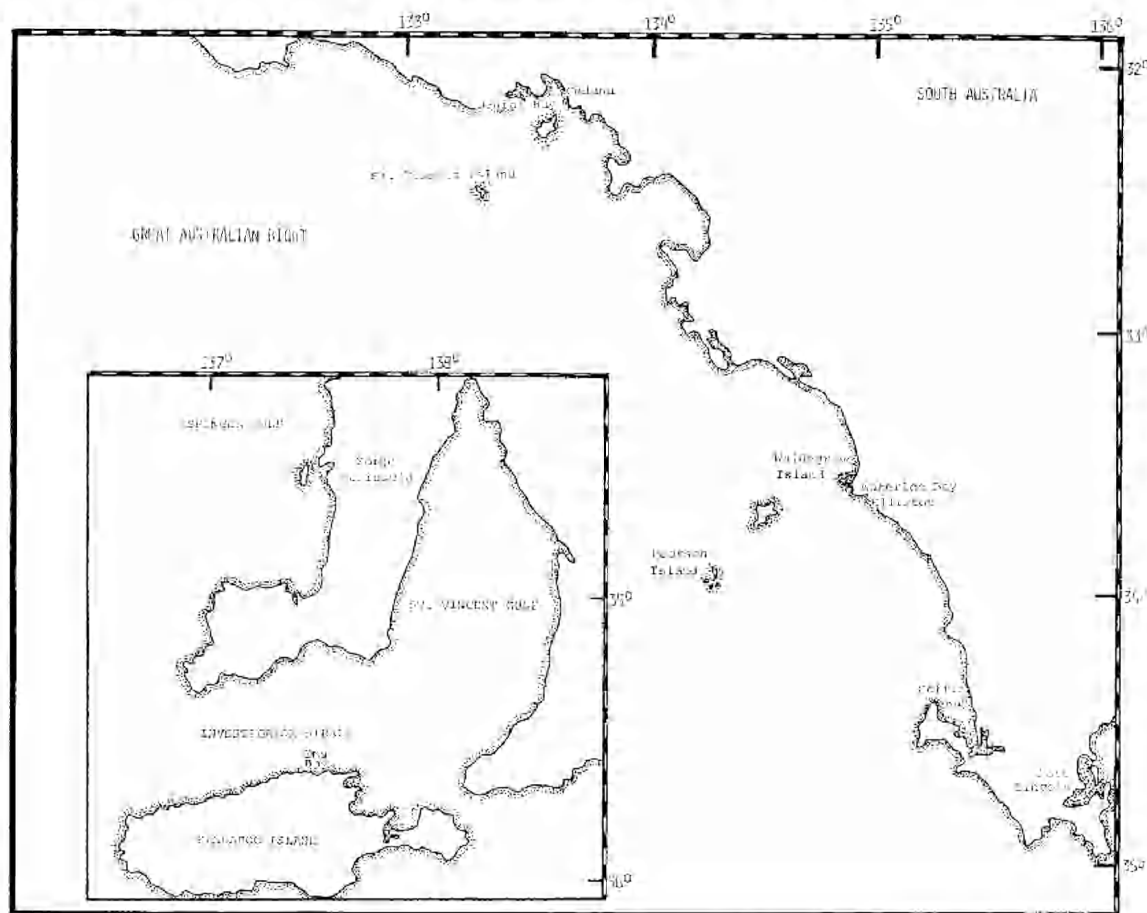


Fig. 60. Map of South Australian locations from which specimens are recorded.

Zoogeography

The known ranges of *Atapozoa marshi* and *Pseudodistoma australis* have been extended from Western Australia to the eastern end of the Great Australian Bight where they overlap with *Distaplia distomoides*, *Euherdmania australis*, *Pseudodistoma cereum* and *Polyandrocarpa lapidosa*, whose ranges have been similarly extended from the east. The ranges of *Aplidium rubricollum* and *Polyclinum neptunium* from the west, and *Ascidia thompsoni*, *Pyura irregularis* and *P. stolonifera* (see Kott 1952) from the east, are also known to extend into either Spencer Gulf or St. Vincent Gulf. Thus the distribution of these ascidian species across the south coast supports the existence of a marine faunal boundary at the eastern end of the Great Australian Bight, separating the Flindersian marine faunal Province from the Maugean Province to the east (Knox 1963). There is less evidence however for a western boundary of the Flindersian Province further south than Cockburn Sound in Western Aus-

tralia. It is possible that the 15 new species described herein will subsequently be found to have wider ranges across the Australian coast and provide further data relating to the western boundary of the Flindersian Province to help resolve the question of the existence of a Western Australian Province (Baudinian of Kott, 1952; see Knox 1963).

The ascidian fauna of Gulf waters of South Australia includes only a limited number of the species that occur along the open coast. Of the species discussed above which terminate their range off the eastern South Australian coast, only *Aplidium rubricollum*, *Polyclinum neptunium*, *Ascidia thompsoni*, *Pyura irregularis* and *P. stolonifera* extend into gulf waters. *Podoclavella meridionalis*, *Distaplia stylifera*, *Didemnum ternatanum*, *Styela pedata*, *Polycarpa tinctor*, and *Pyura pachydermatina* are also apparently absent from gulf waters although their geographic range around the Australian coast is wide. It is probable, therefore, that some ecological factor inhibits the

spread of the ascidian fauna from the open coast into gulf waters. It is possibly the same factor that favours the occurrence of *Distaplia viridis*, *Aplidium pliciferum*, *Didemnum lam-bitum*, *D. pseudodiplosoma*, *Leptoclinides rufus*, *L. kingi*, *Echinoclinum verrilli*, *Ascidia aelara*, *Polycarpa papillata*, *Pyura cataphracta* and *Microcosmus nichollsi* in St. Vincent Gulf and other embayments to the east and north around the Australian coast, although they have not been recorded from the open coast. The ascidian fauna of gulf waters of South Australia is therefore distinct from that of the adjacent coastal waters and has no special zoogeographic affinity with either the Flindersian or the Maugean Provinces.

There are a further 42 species discussed herein that are recorded from both coastal and gulf waters. The majority of these have a wide cosmopolitan distribution or an extended

range from Western Australia to either the boundary of the Maugean marine faunal region in Bass Strait (Hedley 1904, Knox 1963), or further up the eastern Australian coast. Also included in this group of species, however, are *Ctenicella antipoda*, *Pyura scoresbiensis* and *Atapozoa fantusiana*, previously thought endemic to St. Vincent and Spencer Gulfs, and *Aplidium coleloidex* (see Kott 1972a).

Acknowledgements

Grateful thanks are due to Mrs. J. Watson, who collected the material from Investigator Strait for the National Museum of Victoria, and Mr. S. A. Shepherd, of the South Australian Department of Fisheries and Fauna Conservation, who made the collections from most other locations.

The work was done while the author was the recipient of A.R.G.C. Grant D65/15386.

References

- BREWSTER, BERYL I. (1950).—Ascidians of New Zealand, Part V. Ascidians from the east coast of Great Barrier Island. *Trans. R. Soc. N.Z.* **78** (2-3), 354-362.
- BREWSTER, BERYL I. (1953).—Australian ascidians of the sub-family Holozoine and a review of the sub-family, *Trans. R. Soc. N.Z.* **81** (1), 53-64.
- BREWSTER, BERYL I. (1956).—*Atapozoa marthi*, a compound ascidian from Western Australia. *J.R. Soc. W.A.* **40** (1), 31-32.
- BREWSTER, BERYL I. (1957).—Ascidians of New Zealand, Part X. Ascidians from North Auckland. *Trans. R. Soc. N.Z.* **84** (3), 577-580.
- BREWSTER, BERYL I. (1958).—Ascidians of New Zealand, Part XI. Ascidians of the Stewart Island region. *Trans. R. Soc. N.Z.* **85** (3), 439-453.
- CARTER, H. J. (1885). XVIII. Descriptions of sponges from the neighbourhood of Port Phillip Heads, South Australia, continued. *Ann. Mag. nat. Hist.* **15** (5), 197-198.
- DRASCHE, R. VON (1884).—Über einige neue und weniger bekannte ausser-europäische einfache Ascidien. *Denkschr. Akad. Wiss. Wien* **48**, 369-386.
- GOTTSCHEIDT, R. (1898).—Synascidien von ternate. *Abh. Senckenb. naturforsch. Ges.* **24**, 641-666.
- HARTMEYER, R. (1909-11).—Ascidien. (Continuation of work by Seeliger). In H. G. Bronn, "Klassen und Ordnungen des Tier-reiches," **3**, suppl. (89-98), 1281-1772. (Leipzig.) (Abstract, repeating lists of species by A. Schenotieff in *Arch. Naturgesch.*, 1911, **6**, 3-27).
- HARTMEYER, R. (1912).—Die ascidien der deutschen Tiefsee Expedition. *Wiss. Ergebn. dt. Tiefsee-Exped. "Valdivia"* **16** (3), 223-392.
- HARTMEYER, R. (1913).—Tunicata. In L. Schultze, *Zool. u. anthrop. Ergebnisse Forschungsreise in Südafrika*, Bd 5, Lft 2. *Denkschr. med.-naturw. Ges. Jena* **17**, 125-144.
- HARTMEYER, R. (1919).—Ascidien. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia 1910-13. *K. svenska Vetensk.-Akad. Handl.* **60** (4), 1-150.
- HASTINGS, ANNA B. (1931).—Tunicata. *Scient. Rep. Gt Barrier Reef Exped.* **4** (3), 69-109.
- HEDLEY, C. (1904).—The effect of the Bassian Isthmus upon the existing marine fauna; a study in ancient geography. *Proc. Linn. Soc. N.S.W.* **28**, 876.
- HELLER, C. (1878).—Beiträge zur nähern kennt-niss der tunicaten. *Sber. Akad. Wiss. Wien* **77** (1), 83-110.
- HERDMAN, W. A. (1881).—Preliminary report on the Tunicata of the Challenger Expedition. *Cynthidae, Molgulidae, Proc. R. Soc. Edinb.* **11** (3), 52-88; (4), 233-240.
- HERDMAN, W. A. (1891).—A revised classification of the Tunicata, with definitions of the orders, sub-orders, families, sub-families and genera, and analytical keys to the species. *J. Linn. Soc.* **23**, 558-625.
- HERDMAN, W. A. (1899).—Descriptive catalogue of the Tunicata in the Australian Museum. Australian Museum, Sydney. Catalogue 17, 1-139.
- HERDMAN, W. A. and RIDGELL, W. (1913).—The tunicata of the "Thetis" expedition. In *Scientific Results of the Trawl Expedition Thetis. Mem. Aust. Mus.* **4**, 873-889.
- KNOX, G. A. (1963).—Biogeography and inter-tidal ecology of the Australasian coasts. *Oceanogr. mar. Biol. ann. Rev.* **1**, 341-404.
- KOTT, PATRICIA (1952).—The ascidians of Australia. I. Stolidobranchiata and Phlebobranchiata. *Aust. J. mar. Freshw. Res.* **3** (3), 206-333.
- KOTT, PATRICIA (1957).—The ascidians of Australia II. Aplousobranchiata Lohille; Clavelinidae Porhes and Hanly and Polyclinidae Verrill. *Aust. J. mar. Freshw. Res.* **8** (1), 64-110.

- KOTT, PATRICIA (1962).—The ascidians of Australia III. Aplousobranchiata Lohille: Didemnidae Giard. *Aust. J. mar. Freshw. Res.* **13** (3), 265–334.
- KOTT, PATRICIA (1963).—The ascidians of Australia IV. Aplousobranchiata Lohille: Polyclinidae Verrill (continued). *Aust. J. mar. Freshw. Res.* **14** (1), 70–118.
- KOTT, PATRICIA (1964).—Stolidobranch and phlebobranch ascidians of the Queensland coast. *Pap. Dep. Zool. Univ. Qd.* **2** (7), 127–152.
- KOTT, PATRICIA (1966).—Ascidians of north Australia. *Pap. Dep. Zool. Univ. Qd.* **2** (15), 279–304.
- KOTT, PATRICIA (1967).—*Atopozoa* (sic) *decurata* (Sluiter): A discussion of the relationship of the genus and species. *Proc. Linn. Soc. N.S.W.* **91** (3), 185–188.
- KOTT, PATRICIA (1968).—A review of the genus *Halocynthia* Verrill, 1879. *Proc. Linn. Soc. N.S.W.* **93** (1), 76–89.
- KOTT, PATRICIA (1969a).—Antarctic Ascidiacea. A monographic account of the known species based on specimens collected under U.S. Government auspices 1947 to 1963. *Antarct. Res. Ser.* **13**, i–xv, 1–239.
- KOTT, PATRICIA (1969b).—A review of the family Agnesiidae Huntsman 1912, with special reference to *Agnesia glacialis*. *Proc. Linn. Soc. N.S.W.* **93** (3), 444–456.
- KOTT, PATRICIA (1971).—Antarctic Ascidiacea II. Collections made south of 40° south latitude 1963/67, principally by the U.S.N.S. *Eltanin*. *Antarct. Res. Ser. Biology* **16** (4), i–iii, 1–60.
- KOTT, PATRICIA (1972a).—The ascidians of South Australia I: Spencer Gulf, St. Vincent Gulf, and Encounter Bay. *Trans. R. Soc. S. Aust.* **96** (1), 1–52.
- KOTT, PATRICIA (1972b).—Some sublittoral ascidians in Moreton Bay, Queensland. *Mem. Mus. Qd.* **16** (2), 233–260.
- KOTT, PATRICIA (in press, 1).—Plurellidae, a new phlebobranchiate family of the Ascidiacea. *Proc. Linn. Soc. N.S.W.*
- KOTT, PATRICIA (in press, 2).—Notes on some Ascidiaceans from Port Jackson, Botany Bay and Port Hacking, New South Wales. *Proc. Linn. Soc. N.S.W.*
- KOTT, PATRICIA (in press, 3).—Ascidians from Westernport and adjacent locations. *Mem. natn. Mus. Vic.* **34**.
- KOWALEVSKY, A. O. (1874).—Ueber die Kapsung der Ascidien. *Arch. mikrosk. Anat. Entw. Mech.* **10** (1), 441–470.
- LESUEUR, C. A. (1823).—Descriptions of several new species of *Ascidia*. *J. Acad. nat. Sci. Philad.* **3**, 2–8.
- MICHAELSEN, W. (1905).—Revision von Heller's Ascidien-Typen aus dem Museum Godeffroy. *Zool. Jb. (suppl.)* **8**, 71–120.
- MICHAELSEN, W. (1908).—Die Pyuriden (*Halocynthia*) des Naturhistorischen Museums zu Hamburg. *Jb. hamb. wiss. Anst.* **25** (2), 227–287.
- MICHAELSEN, W. (1920).—Die krikobranchien ascidien des westlichen Indischen ozeans: Didemniden. *Jb. hamb. wiss. Anst.* **37**, 1–74.
- MICHAELSEN, W. (1922).—Ascidiae Ptychobranchiae und Diktyobranchiae von Neuseeland und dem Chatham-Inseln. (Papers from Dr. Th. Mortensen's Pacific Expedition 1914–16. No. XI). *Vidensk. Meddr. dansk naturh. Foren.* **73**, 359–498.
- MICHAELSEN, W. (1924).—Ascidiae Krikobranchiae von Neuseeland, den Chatham und den Auckland Inseln. (Papers from Dr. Th. Mortensen's Pacific Expedition 1914–16. No. XXII). *Vidensk. Meddr. dansk naturh. Foren.* **77**, 263–434.
- MICHAELSEN, W. (1930).—Ascidiae krikobranchiae. *Fauna Südwest-Aust.* **5** (7), 463–558.
- MICHAELSEN, W. (1934).—The ascidians of the Cape Province of South Africa. *Trans. R. Soc. Afr.* **22** (2), 129–163.
- MICHAELSEN, W. and HARTMEYER, R. (1928).—Ascidiae diktyobranchiae und ptychobranchiae. *Fauna Südwest-Aust.* **5**, 251–460.
- MILLAR, R. H. (1955).—On a collection of ascidians from South Africa. *Proc. zool. Soc. Lond.* **125** (1), 169–221.
- MILLAR, R. H. (1960).—Ascidacea. 'Discovery' *Rep.* **30**, 1–60.
- MILLAR, R. H. (1962).—Further descriptions of South African ascidians. *Ann. S. Afr. Mus.* **46** (7), 113–221.
- MILLAR, R. H. (1963).—Australian ascidians in the British Museum (Natural History). *Proc. zool. Soc. Lond.* **141** (4), 689–746.
- MILLAR, R. H. (1966).—Ascidacea. Port Philip Survey. *Mem. natn. Mus. Vic.* **27**, 357–375.
- NOFT, J. T. (1892).—On the composite ascidians of the North Shore Reef. *Trans. N.Z. Inst.* **24**, 305–334.
- PERES, J. M. (1952).—Ascidies de la roche littorale Corse. *Rec. Stat. mar. d'Endoume* **6**, 35–44.
- PIZON, A. (1908).—Ascidies d'Amboine. *Rev. Suisse Zool.* **16**, 195–248.
- QUOY, J. & GAIMARD, A. (1934).—Voyages de découvertes de l'Astrolabe 1826–29. Mollusques. *Zoologie* **3**, 559–626; **4**, 304–306.
- SAVIGNY, J. C. (1816).—Mémoires sur les animaux sans vertèbres. Pt. 2. (Paris.)
- SLUITER, C. P. (1898).—Beiträge zur kenntniss die Fauna von Südafrika II. Tunicaten. *Zool. Jb. (Systematik)* **11**, 1–64.
- SLUITER, C. P. (1909).—Die tunicaten der Siboga Expedition Pt. 2. Die merosomen ascidien. *Siboga Exped.* **56B**, 1–112.
- TOKIOKA, T. (1949).—Contributions to the Japanese uscidian Fauna II. Notes on some ascidians collected chiefly along the coast of Kii Peninsula. *Publs. Seto mar. biol. Lab.* **1** (2), 39–64.
- TOKIOKA, T. (1958).—Contributions to Japanese uscidian fauna XII. Sporadic memoranda. *Publs. Seto mar. biol. Lab.* **6** (3), 313–325.
- TOKIOKA, T. (1959).—*Amaroucium erythraeum* Michaelson, a compound Ascidian from the Cape Province. (Biological Results of the Japanese Antarctic Research Expedition 5). *Spec. Publs. Seto mar. biol. Lab.* (329).

- TOKIOKA, T. (1961).—Ascidians collected during the Melanesia Expedition of the Osaka Museum of Natural History. I. Ascidians presented by Dr. R. L. A. Catala of the Aquarium of Noumea. *Publs. Seto mar. biol. Lab.* **9** (1), 104–138.
- TOKIOKA, T. (1967).—Pacific Tunicata of the United States National Museum. *Bull. U.S. natn. Mus.* **251**, 1–242.
- TRASON, W. B. (1963).—The life cycle and affinities of the colonial ascidian *Pycnocyclus clavella stanleyi*. *Univ. Calif. Publs. Zool.* **65** (4), 283–326.
- VAN NAME, W. G. (1918).—Ascidians from the Philippines and adjacent waters. *Bull. U.S. natn. Mus.* **100** (1), 49–174.
- VAN NAME, W. G. (1945).—The North and South American ascidians. *Bull. Am. Mus. nat. Hist.* **84**, 1–476.
- VASSEUR, P. (1967).—Ascidies de Nouvelle-Calédonie. Editions de la Fondation Singer-Polignac, 127–146, 2 pls.

Appendix I—Station List

Stations are listed in the order north to south and west to east.

DENIAL BAY. (Coll. I. Thomas). Lat. 32°13'S; Long. 133°38'E.

Near Ceduna; in *Posidonia* community; depth 10m; 1965.

Atapozoa fantasiana
Sycozoa cerebriformis

OFF ST. FRANCIS I. (Coll. S. Shepherd). Lat. 32°31'S; Long. 133°15'E.

Rocky bottom; slight current; depth 55 m; 8.i.1971.

Pseudodistoma cereum
Polyandrocarpa simulans
Pyura australis
Herdmania momus

WALDEGRAVE ISLAND. (Coll. S. Shepherd). Lat. 33°36'S; Long. 134°46'E.

Strong surge; depth 20 m; 17.iv.1970.

Distaplia distomoides
Synoicum papilliferum
Botrylloides magnicoecum
Botryllus schlosseri (22 m)
Pyura australis

Rocky bottom; strong surge; depth 22 m; 23.x.1970.

Euherdmania australis
Aplidium colelloides
Oculinaria australis
Botrylloides leachi
Styela pedata
Polycarpa tinctor
Pyura australis
Pyura spinifera (covered with sponge)
Pyura pachydermatina
Herdmania momus

1 Km N.W. OF WALDEGRAVE I. (ANXIOUS BAY). Lat. 33°33'S; Long. 134°46'E.

Rocky bottom; slow current; depth 23 m; 11.v.1971.

Clavelina mirabilis (attached to limestone).
Distaplia distomoides
Distaplia stylifera
Symplegma arenosa
Botryllus schlosseri
Stolonica truncata
Holozoinae sp. (growing on red algae)
Polycarpa clavata (growing on brown or red algae: *Sargassum* or *Osmundaria*)

Herdmania momus (with red algae attached)
Rocky bottom with sand patches; slow current; depth 23 m; 11.v.1971.

Podoclavella cylindrica
Synoicum papilliferum
Stolonica truncata
Polycarpa pedunculata
Pyura australis

Rocky bottom; slight surge; depth 22 m; 23.x.1970.

Clavelina nodula
Polycitor giganteum
Pseudodistoma australis
Pseudodistoma cereum
Aplidium flavolineatum
Symplegma arenosa
Polycarpa clavata (attached to rock)
Polycarpa pedunculata

WATERLOO BAY (ELLISTON). (Coll. S. Shepherd). Lat. 33°38'S; Long. 134°51'E.

Roof of caves; strong surge; depth 6 m; 13.v.1971.

Clavelina baudinensis
Podoclavella moluccensis
Distaplia distomoides
Eudistoma renieri
Pseudodistoma cereum
Aplidium lobatum

Polysyncrator paradoxum
Didemnum candidum
Didemnum moseleyi

Ascidia thompsoni
Ascidia sydneyensis
Polyandrocarpa simulans (growing on *Ascidia sydneyensis*)

Outside bar; very strong surge; depth 17 m; 12.v.1971.

Sycozoa cerebriformis
Polychinum neptunium
Aplidium elatum
Oculinaria australis
Pyura pachydermatina

Outside bar, in caves; strong swell; depth 17 m; 14.v.1971.

Pycnoclavella diminuta
Euherdmania australis
Ritterella herdmania
Placentola ellistoni
Trididemnum cerebriforme (investing *P. diminuta*)

Stolonica australis (around base of *Euherdmania australis*)
Molgula ellistoni (adhering to *E. Australis*)

Inside bar; depth 6 m; 12.v.1971.

Polycitor giganteum
Pseudodistoma australis
Didemnum moseleyi
Polycarpa pedunculata

Inside bar; strong surge; on vertical face; depth 6 m; 12.v.1971.

Aplidium pantherinum

Near entrance to bay, in caves; depth 3 m; 14.v.1971.

Pseudodistoma cyrnusense
Polycrinum neptunium
Molgula sabulosa

Floor of cave; depth 16 m; 12.v.1971.

Atapozoa mirabilis

Centre of bay; depth 11 m; 12.v.1971.

Atapozoa mirabilis

On roof of caves; depth 3-5 m; 14.v.1971.

Aplidium flavolineatum

Elliston Bay

Cystodytes dellechiaiei

Trididemnum spiculatum

Didemnum ternatanum

Oculinaria australis (with *E. australis* and *M. ellistoni*)

Botrylloides leachi

PEARSON ISLAND. (Coll. S. Shepherd). Lat. 33°56'S; Long. 134°15'E.

Rough-water coast, 400 m offshore on gravelly bottom, attached to shell or rock fragments; moderate surge; depth 50 m; 9.i.1969.

Leptoclinides fungiformis
Polycarpa clavata
Pyura australis
Herdmania momus

Rough-water coast; in caves; moderate surge; depth 35 m; 10.i.1969.

Podoclavella meridionalis
Aplidium rubricollum
Styela pedata
Polycarpa pedunculata
Herdmania momus

Sandy bottom between Dorothee and Veteran Is. Lat. 34°1'S; Long. 134°15'E. Slight surge; depth 70 m; 11.i.1969.

Polycitor giganteum
Botrylloides magnicoecum
Polycarpa pedunculata
Pyura scoresbiensis

Outside Pearson I; depth 35 m.

Podoclavella meridionalis
Leptoclinides fungiformis
Styela pedata

COFFIN BAY. (Coll. S. Shepherd). Lat. 34°38'S; Long. 135°30'E.

Oyster Trays, at low water; slow currents; no sediments; October 1970.

Styela plicata

SPENCER GULF. (Coll. S. Shepherd). Lat. 34°2'S; Long. 137°23'E. Tipara Reef; depth 11 m; 20.viii.1971.

Pycnoclavella diminuta
Herdmania momus

INVESTIGATOR STRAIT (Coll. J. Watson).

Station X7; depth 30 m; 10.i.1971. Lat. 35°16'S; Long. 137°30'E.

Didemnum moseleyi

Station X9; depth 31 m; 19.i.1971. Lat. 35°17'S; Long. 137°30'E.

Polycarpa pedunculata

Pyura scoresbiensis

Station X11; depth 30 m; 19.i.1971. Lat. 35°19'S; Long. 137°30'E.

Pyura scoresbiensis

Station X15; depth 32 m; 19.i.1971. Lat. 35°23'S; Long. 137°30'E.

Polycitor giganteum

Polysyncrator magnilarvum

Polycarpa pedunculata

Pyura scoresbiensis

Station X?, 19.i.1971.

Polyandrocarpa simulans

Station X17; depth 35 m; 19.i.1971. Lat. 35°24'S; Long. 137°30'E.

Trididemnum cerebriforme

Pyura scoresbiensis

Herdmania momus

Station X19; depth 34 m; 20.i.1971. Lat. 35°26'S; Long. 137°30'E.

Fuherdmania australis

Colonial stolidobranch—Gen. and sp.?

Ascidia sydneyensis

Polycarpa pedunculata

Halocynthia hispida

Station X21; depth 34 m; 17.i.1971. Lat. 35°28'S; Long. 137°29'E.

Polycitor giganteum

Polycarpa pedunculata

Station X25; depth 35 m; 17.i.1971. Lat. 35°31'S; Long. 137°29'E.

Polycarpa pedunculata

Station X27; depth 31 m; 17.i.1971. Lat. 35°33'S; Long. 137°29'E.

Didemnum moseleyi

Polycarpa pedunculata

Pyura australis

Station Y6; depth 23 m; 28.i.1971. Lat. 35°17'S; Long. 137°16'E.

Leptoclinides reticulatus

Polysyncrator magnilarvum

Metandrocarpa indica

Polyandrocarpa simulans

Polycarpa pedunculata

Pyura irregularis

Station Y12; depth 33 m; 24.i.1971. Lat. 35°23'S; Long. 137°17'E.

Polycarpa pedunculata

Station Y14; depth 32 m; 23.i.1971. Lat. 35°25'S; Long. 137°17'E.

Atapozoa marshi

Pyura scoresbiensis

Station Y16; depth 35 m; 2.i.1971. Lat. 35°26'S; Long. 137°17'E.

Sycozoa pedunculata

Station Y17; depth 34 m; 20.i.1971. Lat. 35°27'S; Long. 137°18'E.

Atapozoa marshi

Station Y18; depth 31 m; 23.i.1971. Lat. 35°28'S; Long. 137°18'E.

Oxycorynia arenosa

Polycitor obeliscum

Colonial stolidobranch—Gen. & sp.?

Ascidia sydneyensis

Station Y19; depth 33 m; 20.i.1971. Lat.
35°29'S; Long. 137°18'E.
Polyandrocarpa lapidosa
Polyandrocarpa simulans
Pyura spinifera
Station Y21; depth 32 m; 20.i.1971. Lat.
35°32'S; Long. 137°18'E.
Aplidium colelloides
Polycarpa clavata
Pyura australis
Pyura tendata
Station Y23; depth 32 m; 17.i.1971. Lat.
35°33'S; Long. 137°18'E.
Polycarpa pedunculata
Station Y?; 20.i.1971.
Didemnum moseleyi

Station Z?
Colonial stolidobranch—Gen. & sp.?
Pyura spinifera
Stations Z9, 11; depth 38 m; 25.i.1971. Lat.
35°30'S; Long. 137°8'E.
Polycarpa pedunculata
? (Label illegible)
Colonial stolidobranch—Gen. & sp.?
Ctenicella antipoda
KANGAROO ISLAND. (Coll. J. E. Watson).
Lat. 35°35'S; Long. 137°31'E. Off Emu Bay,
22.i.1971.
Didemnum moseleyi
Didemnum patulum
Polycarpa pedunculata
Pyura australis

Index to Genera and Species

	Page		Page
<i>Aplidium colelloides</i>	176	<i>Placentella ellistoni</i> n.sp.	173
<i>Aplidium elatum</i> n.sp.	177	<i>Podoclavella cylindrica</i>	167
<i>Aplidium flavolineatum</i>	176	<i>Podoclavella meridionalis</i>	167
<i>Aplidium lobatum</i>	176	<i>Podoclavella moluccensis</i>	167
<i>Aplidium pantherinum</i>	176	<i>Polyandrocarpa lapidosa</i>	184
<i>Aplidium rubricollum</i>	176	<i>Polyandrocarpa simulans</i> n.sp.	184
<i>Ascidia sydneyensis</i>	182	<i>Polycarpa clavata</i>	186
<i>Ascidia thompsoni</i>	180	<i>Polycarpa pedunculata</i>	186
<i>Atapozoa fantasiana</i>	168	<i>Polycarpa tinctor</i>	186
<i>Atapozoa marshi</i>	168	<i>Polycitor giganteum</i>	171
<i>Atapozoa mirabilis</i> n.sp.	168	<i>Polycitor obeliscum</i> n.sp.	171
<i>Botrylloides leachi</i>	185	<i>Polyclinum neptunium</i>	175
<i>Botrylloides magnicoecum</i>	185	<i>Polysyncrator magnilarvum</i>	178
<i>Botryllus schlosseri</i>	185	<i>Polysyncrator paradoxum</i>	178
<i>Clavelina baudinensis</i>	166	<i>Pseudodistoma australis</i>	172
<i>Clavelina mirabilis</i> n.sp.	165	<i>Pseudodistoma cereum</i>	173
<i>Clavelina nodula</i> n.sp.	166	<i>Pseudodistoma cyrusense</i>	173
<i>Ctenicella antipoda</i>	189	<i>Pycnoclavella diminuta</i>	170
<i>Cystodytes dellechiaiei</i>	172	<i>Pyura australis</i>	186
<i>Didemnum candidum</i>	179	<i>Pyura irregularis</i>	187
<i>Didemnum moseleyi</i>	179	<i>Pyura pachydermatina</i>	187
<i>Didemnum patulum</i>	179	<i>Pyura scoresbiensis</i>	187
<i>Didemnum ternatanum</i>	179	<i>Pyura spinifera</i>	186
<i>Distaplia distomoides</i>	170	<i>Pyura tendata</i> n.sp.	187
<i>Distaplia stylifera</i>	170	<i>Ritterella herdmania</i>	172
<i>Eudistonia renieri</i>	171	<i>Stolonica australis</i>	183
<i>Euherdmania australis</i>	172	<i>Stolonica truncata</i> n.sp.	183
<i>Halocynthia hispida</i>	189	<i>Styela pedata</i>	185
<i>Herdmania momus</i>	189	<i>Styela plicata</i>	185
<i>Leptoclinides fungiformis</i> n.sp.	180	<i>Sycozoa cerebriformis</i>	170
<i>Leptoclinides reticulatus</i>	180	<i>Sycozoa pedunculata</i>	170
<i>Metandrocarpa indica</i> n.sp.	182	<i>Symplegma arenosa</i> n.sp.	182
<i>Molgula ellistoni</i> n.sp.	190	<i>Synoiicum papilliferum</i>	177
<i>Molgula sabulosa</i>	190	<i>Trididemnum cerebriforme</i>	178
<i>Oculinaria australis</i>	184	<i>Trididemnum spiculatum</i>	178
<i>Oxycorynia arenosa</i> n.sp.	167		